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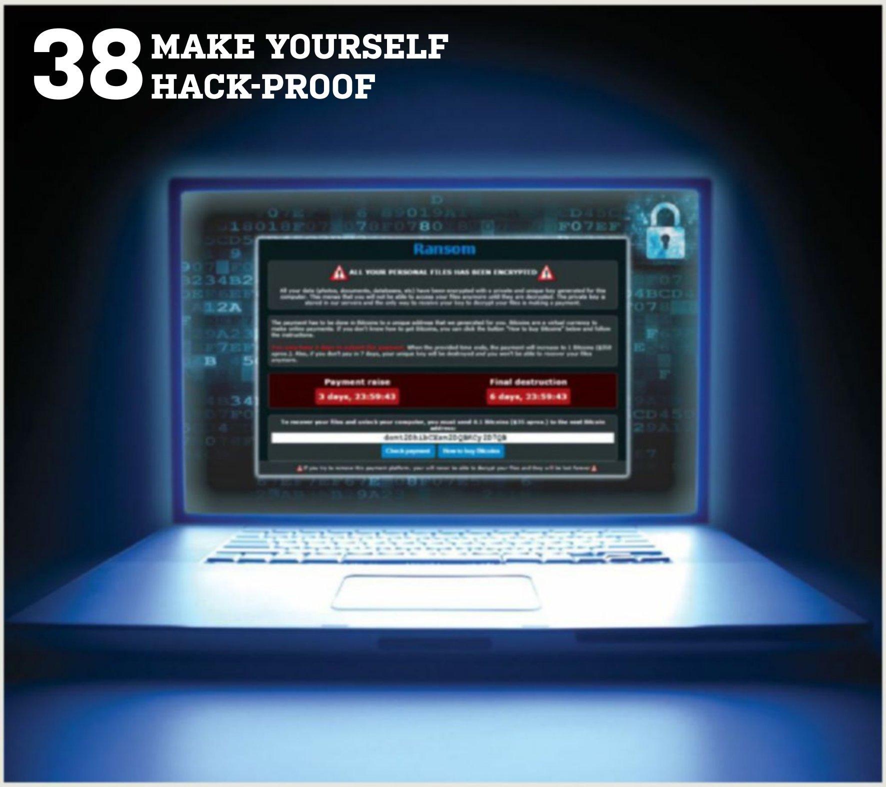
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Payment raise
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Tuan
Nguyen

THE VR-READY PRICE IS RIGHT

THERE'S SOMETHING transformative happening in the PC space. No, it's not that CPUs are getting faster, or GPUs are putting out higher frame rates. It's not even VR. In fact, it's not the release of any single revolutionary device. It's pricing.

If I'm going to shell out for a high-performance PC, I'm typically thinking of spending over $1,000 to get something decent, with a penchant for goodies in the graphics department. High-performance storage will typically follow, with a focus on RAM next. The CPU is probably last in line for me, as pretty much every CPU available right now puts out fantastic performance at every major price point. I reckon that the majority of software still hasn't caught up with the rate of improvements in CPU development.

Now, though, both AMD and Nvidia have done something shocking: they've released their new architectures at shockingly low prices. Nvidia announced to the world that its new Pascal cards can deliver above Titan X performance for $500 or less, besting even two GTX 980 cards in SLI. AMD, on the other hand, delivers exceptional performance with its new Radeon RX 480, for a incredible price of just $200.

With these new pricing milestones, you can expect to see much more affordable systems that deliver great performance. Enough performance, in fact, to build an excellent VR-ready system for less than $1,000—much less.

Think $700. That's right—you can have a machine up and running, capable of powering either the Oculus Rift or the HTC Vive, for half the price of Oculus's original recommendation. Given that a VR headset already costs upward of $700 to $800, you're going to want to save every dollar you can. And with Oculus's original $1,500 spec including a GTX 970, it's now possible to get performance that's even better than that for much lower.

Will you have to make any trade-offs? Not as many as you might think. If you're willing to build your own, you can often save a good amount of cash, but there are some system integrators out there that will oftentimes have pricing so good that the components cost less than what you would purchase them for individually online.

2016 is the year of VR, and it's been a long time coming. Content is starting to really shine. I've tried every VR headset on the market, including the ones still in development. There's a lot of progress made, and the ones already available for purchase are both excellent in their own regard—my favorite being the HTC Vive. If you haven't experienced VR yet, it's definitely the future of computing and entertainment.

And now, building a system that shines in VR costs as much as a high-end graphics card did a year ago. And, in my opinion, that's just as transformative as any groundbreaking new product release.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Apple vs. Spotify

Rivals square up over Apple's commission

Apple's control of iTunes, and its unpopular 30 percent commission, looks likely to receive legal scrutiny.

TWO OF THE BIGGEST music streaming services are locked in a nasty fight over fees, and it has serious ramifications for everyone, but especially Apple. iTunes takes a straight 30 percent cut of any in-app purchase, and offers no access to alternative billing systems. The spat was triggered when an updated version of Spotify's iOS app was rejected. It was rejected because it bypassed Apple's billing system, and sent you to Spotify's instead.

Spotify claimed Apple was trying to "diminish the competitiveness of Spotify on iOS and as a rival to Apple Music." Apple said the updated version violated its App Store rules, which are applied equally to all, whether or not they happen to be rivals. Spotify accused Apple of using its approval process as "a weapon to harm competitors."

It quickly descended from there, getting increasingly vitriolic. Spotify's Head of Communications and Public Policy, Jonathan Prince, claimed that Apple "has long used its control of iOS to squash competition in music." Apparently, Apple makes more out of Spotify subscriptions than it does out of Apple Music subscriptions: "They want to have their cake and eat everyone else's, too." Spotify went as far as charging an extra $3 on its subscription for a while, if you happen to take it out on an Apple device.

Apple's response was inflexible and blunt. "Our guidelines apply equally," said one of its lawyers in a letter that ended with: "I would be happy to facilitate an expeditious review and approval of your app as soon as you provide us with something that is compliant with the App Store's rules." Ouch! Basically a stonewall.

Spotify went to Washington to complain, where it received some sympathy, and where the matter looks likely to be settled, if some compromise can't be figured out. Massachusetts senator Elizabeth Warren commented that "Apple has placed conditions on its rivals that make it difficult for them to offer competitive streaming services."

There are some big players watching from the sidelines on how this plays out. Amazon, for one, has never been happy with the cut Apple takes on its e-book sales. It even updated its Kindle app with a workaround, which guided you to Amazon to make a purchase when you searched for a free sample. Pandora is developing a music streaming service, and will be in the same boat as Spotify shortly. Netflix and other video streamers have a stake in this, too.

Streaming music is hugely popular—it recently overtook streaming video—but profits can be elusive. Spotify made a loss of $194 million last year, largely down to payments to artists and labels. Given such tight margins, Apple's cut looks ripe for negotiation.

Apple is free to make its own rules for its own software, and its in-app purchase rules are quite clear; you are not permitted to sidestep the process. It could legitimately pull the plug on Spotify completely—it has removed uncooperative companies before. Strictly speaking, it has done nothing wrong, simply applied the rules—rules that it has defined for itself, of course.

However, being seen to leverage your control of an OS or app to make profits from third parties directly tends to be met with a poor response by legislators. Just ask Microsoft. Congress likes the idea of an open and competitive marketplace, and Apple's 30 percent "tax" on rivals selling similar services in the same arena doesn't play well. The potential loss for Apple, if it is forced to relinquish control of billing, or make a hefty cut to percentages, is huge. **–CL**

> “
> Apple makes more out of Spotify subscriptions than it does from Apple Music ones

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Windows 10
Anniversary Update

HAPPY BIRTHDAY WINDOWS 10

Major update brings your Xbox games to your PC for free

THIS AUGUST, WINDOWS 10 gets a major free update for its birthday, and it's a pretty big one, with everything from a new theme and emoji, through to extensive updates to core applications. One major new feature that got a lot of people excited at E3 was Xbox Play Anywhere. Under this, when you buy a compatible PC or Xbox game, you'll get both versions by default. Saved games are accessible on both systems, and you can pick up where you left off on either machine—one game on two machines.

Initial excitement was damped down a little when it emerged that not every title from Microsoft Studios will be compatible, and cross-platform multiplayer support isn't a given. However, some heavyweight titles are coming to the party, including *Gears of War 4* and *Halo Wars 2*. Xbox Play Anywhere is scheduled to launch on September 13, and there are currently 13 compatible titles.

Other significant Win 10 upgrades include those to Ink and Cortana. Both get much better integration with apps and devices, and a host of smart features. Draw a line on a map, and it'll calculate the distance; create a path, and you can ask Cortana to send it to your phone, for example.

Edge finally gets browser extensions, and the Start menu has been redesigned yet again, with more "suggested applications" (not so welcome). Many of the updates are aimed at improving integration with your phone, including neat touches such as pop-up warnings about low battery. You can also answer phone calls on your PC, and use Hello to unlock your PC from your phone. Oh, yes, and there's Linux Bash shell for developers. Microsoft claims that it has listened to suggestions and added features people wanted. It has also updated Windows Update, which is going to see a lot of use soon. **–CL**

ANDROID NOUGAT

OS UPGRADE THIS FALL

ANDROID 7.0, AKA NOUGAT, has been out as a developer preview since June, and is expected to appear pre-installed on new phones in September, and as an update soon after.

There's a host of tweaks to the way you interact with the OS and apps, and some look and feel changes—new folder and emoji designs, for example. Under the skin, big additions include native VR support, thanks to Daydream, though you need a compatible phone, with the required sensors and high-speed, high-res screen. Of more immediate interest is the Vulkan graphics API, which should give a boost to game graphics by getting the most from multi-core and multi-threading processors. There's also a useful new split-screen mode.

Doze mode has been improved, with new intermediate modes, where apps can run background tasks. A new JIT (Just In Time) compiler means apps should be half the size and install much faster. Updates will also be less painful, thanks to a seamless upgrade system which means it can update in the background. Nougat will go head to head with iOS 10. **–CL**

TESLA CRASH

Autopilot function called into question

A SENATE COMMITTEE has called on Tesla to explain what role its Autopilot function played in a recent fatal accident. Meanwhile, the victim's family has hired a personal injury lawyer to investigate whether a claim against Tesla is viable. The incident was the first fatality in a self-driving car, and received copious publicity.

Tesla has always said that Autopilot was a driving assist system, and drivers still need to keep their hands on the wheel and pay attention. *Consumer Report* magazine has called for Tesla to deactivate parts of Autopilot until it can detect that the driver is engaged and attentive. The very term "Autopilot" has been criticized as implying that it does more than it actually does. Autonomous self-driving cars are the subject of a great deal of research and development, and the tech looks likely to arrive within years. Public reaction and behavior is another matter. There will be new kinds of incidents, and apportioning blame on to software is a sticky issue. The cars may well be ready before we are. **–CL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

POKEMON GO SETS RECORDS
Nintendo's shares are looking healthy as *Pokémon Go* becomes the most successful mobile app of all time.

MICROSOFT COMES TO STEAM
Microsoft is to start putting games on Steam. Whether Steam also gets the big premium titles alongside Windows Store remains to be seen.

SEGA SATURN CRACKED
An engineer has cracked the DRM on the Saturn. It took three years, but enables you to run games direct from images on a USB drive.

TRAGEDIES

JAIL SENTENCE FOR HACKER
A Chinese hacker has been given four years in jail for his part in attempts to steal military jet secrets.

$3 BILLION IN DAMAGES
Oracle has to pay Hewlett Packard Enterprises huge damages for lost profits after it reneged on a contract.

BOTS AND BUTTS
NASA's site on Twitter for Kepler, the space observatory for the search for planets, was hacked, and visitors were (briefly) treated to something else roughly planet-shaped instead.

Jarred Walton

TECH TALK

Supercomputers vs. PCs vs. the Human Brain

GO BACK A DECADE or two, and all the fastest supercomputers were running RISC processors. Lately, though, the Top 500 charts have been filled with systems running x86 chips, often helped with compute GPUs, such as Nvidia's Tesla. For several years, the fastest system was the Tianhe-2, capable of nearly 34 PFLOPS (trillions of floating point operations per second) in the LINPACK benchmark.

It uses a combination of 32,000 12-core Xeon CPUs paired with 48,000 Xeon Phi 3120P co-processors (57 cores each), giving it 3.12 million processing cores.

If that sounds a lot, the new TianhuLight supercomputer nearly triples performance, thanks to a custom-designed ShenWei SW26010 processor. We don't know the manufacturing process, but we do know that each chip has 260 cores, with one chip per node. Combined, that gives TianhuLight 10,649,600 cores, each running at 1.45GHz, and the result is a supercomputer capable of 93 PFLOPS in LINPACK.

That's an interesting figure, as experts estimate simulating the human brain will require 50–1,000 PFLOPS. TianhuLight has crossed that lower threshold, and we're likely to see supercomputers in the 300–500 PFLOPS range by 2020.

How does this compare to Dream Machine 2016? It's not looking so hot for PCs, with DM16 puttering along at around 0.02 PFLOPS. But just as we can't compare FLOPS and the human brain (with a pen and paper, I'd rate about 0.03 FLOPS), comparing supercomputers with PCs providing real-time interactions becomes a mess. Can TianhuLight run *Crysis?* Not really—it's not designed to handle real-time user input and graphics. But with the right software, it might be able to learn how to play *Crysis.*

That's the real difficulty with supercomputers and artificial intelligence: the software. All the processing potential in the world is useless if it's not put to good use, and good computer algorithms can mean the difference between minutes and days (or years) when it's time to solve problems. In the past, supercomputers have used expert systems—systems designed by experts from a specific field, with the goal of solving one particular problem (playing chess or checkers, for example). Now, the big hype is all about deep learning, where convolutional neural networks can go many layers deep, and act more like a human brain than a bunch of hyper-fast FLOPS calculators.

China's TaihuLight has 40,960 nodes, with 260 cores per node.

> “Can TianhuLight run *Crysis?* No. But with the right software, it might learn how to play it.

One great example of this is the world of board games. In 1997, IBM's Deep Blue was able to beat Garry Kasparov in a series of six games of chess. It was the first time a computer had been able to defeat a grandmaster chess player. It was done mostly by brute force, with Deep Blue searching and evaluating millions of positions to choose the best move. It was projected that, due to the increased complexity, it would be 100 years before a computer could do the same with the Chinese game Go. Fast forward to 2016, and Google's DeepMind AlphaGo has done just that. The difference? Software.

Instead of brute force, AlphaGo uses deep learning, playing against itself for millions of games, and creating its own strategies. And the hardware behind AlphaGo is relatively tame in comparison to the top supercomputers, with just 1,202 CPUs and 176 GPUs. Take these algorithms and apply them to other tasks, and just imagine the sort of learning that could be done with the tens of thousands of processors.

SkyNet is one fearmongering prospect, sure, but I'm more optimistic. I, for one, welcome our new digital overlords. Living in a virtual reality matrix doesn't sound so bad. Now, where's my Vive?

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

OPEN SOURCE

How to Ensure Your Data Survives a Cloudburst

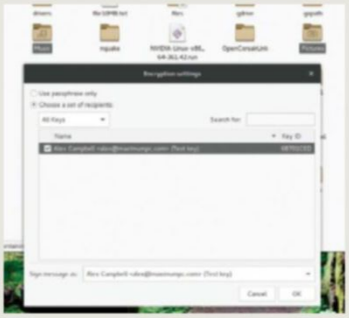
LOOKING BACK ON the past few years, it has become abundantly clear what the trend is for document storage. People are storing documents, photos, and other data in the "cloud," a buzzword for the nebulous array of services that offer storage in data centers around the world. But the cloud isn't always the most private place to store data.

Don't get me wrong. In terms of data longevity and access, cloud services, such as Dropbox and Google Drive, offer clear advantages over portable drives. Servers have near 100 percent uptime, allowing access at any moment. Distributed data centers mean that catastrophic events won't necessarily result in data loss from the user's point of view.

That said, a careful reading of a provider's privacy statement should give you pause. Google, for example, crawls your documents in order to serve up ads and provide contextual services, such as Google Now. And most US-based companies will hand over access to your data to the US government if served with a subpoena or national security letter.

That's not the least of it. Data breaches and (spear) phishing attacks can expose your data to hackers, who sell it to the highest bidder, or use it for extortion. More ominously, US courts have basically authorized the NSA and FBI to hack into user accounts without a company's consent or a warrant. It's enough to make you want to break out your tinfoil hat and never store anything online again. But there is a way to leverage the convenience and security of cloud storage, while maintaining privacy. It just means taking a hit to the convenience side of things.

The trick is to encrypt your data before uploading it. That way, even if the data is stolen, it is unreadable to the attacker, company, or government without the key to decrypt it. Password managers, such as Dashlane and LastPass, use this methodology in their products. As a case in point, LastPass had user data stolen last year, but because that data was encrypted, it was considered safe as long as users employed a strong passphrase and/or two-factor authentication. (Weak and/or reused passphrases are often the biggest weak points.)



Encrypting files with GPG is a cinch with Seahorse's plugin for Nautilus.

> US courts have basically authorized the NSA and FBI to hack into user accounts without consent or a warrant.

The hard way to encrypt all of this data is to encrypt each file you upload independently. But keeping all those individual passphrases synched can be tedious, even with a password manager. This can be simplified a little by using PGP public keys to encrypt each file, but even that can be tedious, as you have to manually encrypt each one.

The other, more attractive, option is to use an encrypted container or compressed archive file (like a ZIP or tarball). Windows users can utilize VeraCrypt to create encrypted containers. Linux users can use Tomb (https://github.com/dyne/Tomb), which is a front end for cryptsetup and LUKS. Tomb's features include an easy-to-use command structure, and the ability to hide keys in images or print them out to QR codes. (Tomb has an experimental Android app, too, but it requires your phone to be rooted.) If you prefer the archive route, you can encrypt the archive with PGP. The downside to the container/archive approach is that you have to download the whole archive or container each time you want to access a file within it.

Whatever method you choose, encrypting your data before it heads to the cloud is a good practice to adopt in the era of security breaches and mass surveillance. You can't control whether or not someone gains access to your cloud storage account, but you can control how hardened the data within it is.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

THE BIGGEST GROSSING MOVIES BASED ON GAMES

DOOM Admittedly, it's a pretty terrible film, but the first-person section is comedy gold.

MAX PAYNE Stylistically on point, but taking itself far too seriously, this could have been so much better.

SILENT HILL It may focus a little too much on gore, but *Silent Hill* still manages to be unsettling.

HITMAN Another game-to-film title that takes itself too seriously, but it does look good.

RESIDENT EVIL Some great jump scares launched a film franchise that should have stopped a long time ago.

LARA CROFT: TOMB RAIDER Angelina Jolie made a great Lara Croft, even if the plot is a little silly.

PRINCE OF PERSIA: THE SANDS OF TIME Take a big budget, add popcorn, then turn your brain off!

WARCRAFT: THE BEGINNING Played *WoW?* Then you're obliged to like this. It's made lots of cash, too.

Future

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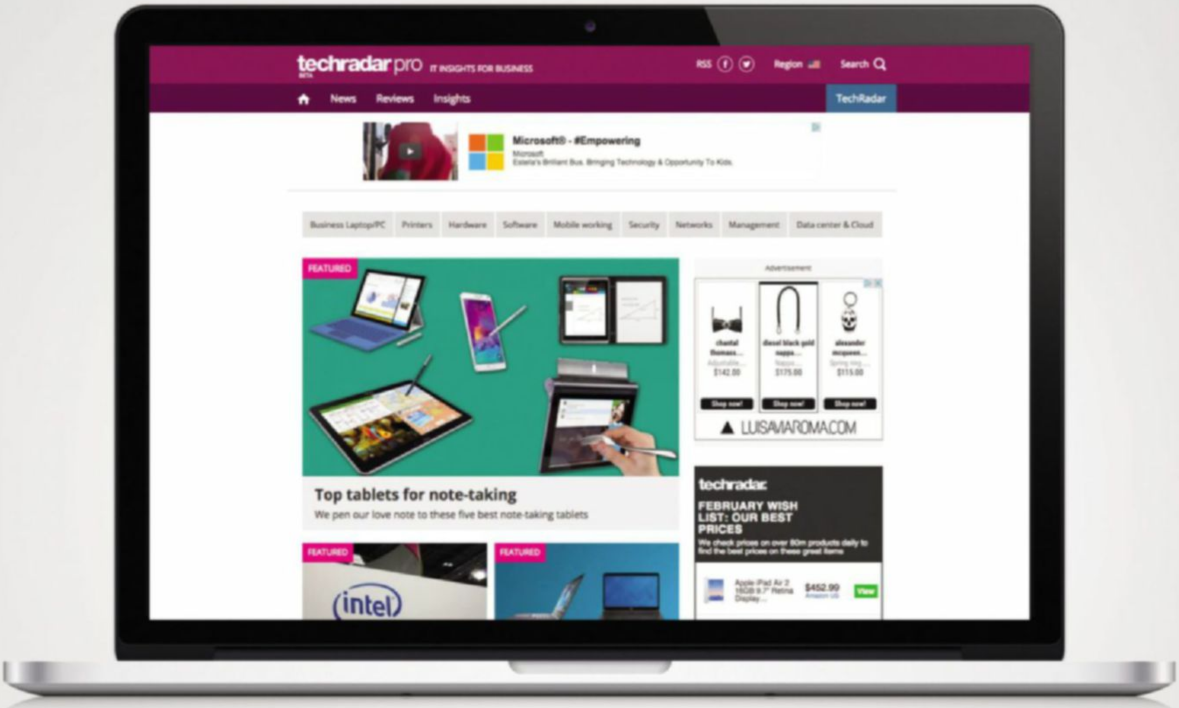
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DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Playing UT 2004
> Bottleneck Issues
> Fine-Tuning SSDs

UT 2004 in Win 10

Greetings, Doc! I'm a 63-year-old retired gamer who's been building computers since 2006. Thanks to your magazine, my main PC is inside a Cooler Master HAF 932 case. It consists of an ASRock Fatal1ty Z97X Killer motherboard, a water-cooled Core i7-4790K CPU, a Samsung 850 Pro SSD, 16GB of Corsair DDR3-2400, a Radeon R9 290, and a 1,200W power supply. I upgraded from Windows 8.1 to Windows 10 on my main gaming rig, and from Windows 7 to 10 on my backup.

When I fire up *Unreal Tournament 2004* on either machine, it crashes and asks me to submit a bug report. I checked online, and the only solution I could find suggested changing a setting called "ReduceMouseLag=True" to "=False" in the ut2004.ini file. I opened the file in Notepad, but couldn't find the setting. So, under "D3DRenderDevice," I added it and loaded the game again, but it continues to crash.

This is a very important game to me, if only for nostalgia's sake. It was one of my first FPS-style titles, aside from *James Bond 007: Nightfire,* which also doesn't work. I've spent years downloading maps and mods to the tune of over 24GB. Could you please help get it running again? I really like Windows 10. The games that work run smoothly. But if there's no solution, I'll have to go back to Win 8.1. I'd really appreciate your help! **–Howard Coon**

THE DOCTOR RESPONDS: It's frustrating when upgrading to the latest and greatest causes something old and beloved to break. But all hope is not lost, Howard. Plenty of gamers are still playing *UT 2004* under Windows 10. The Doc is missing a bit of information, though, such as whether you're using the 32- or 64-bit version of *Unreal Tournament.* Given your reference to the "D3DRenderDevice" key in ut2004.ini, he'll assume this is the 32-bit build in question.

First, are you certain you have the latest patch for *UT2004*—v3369? If not, grab it. If so, go back into ut2004.ini. The "ReduceMouseLag=True" setting should appear several times in the .ini file. In Notepad, expand the Edit menu and click "Find." One instance should show up for each renderer option available (to check which renderer you're using, scroll up to the "[Engine.Engine]" heading, and see which "RenderDevice" entry doesn't have the semi-colon in front of it). The line you added for "ReduceMouseLag" under "D3DRenderDevice" only works if you're using DirectX 8.

Another option is to use OpenGL. Add a semi-colon in front of whatever renderer is active, and delete it from the line "RenderDevice=OpenGLDrv.OpenGLRenderDevice" under "[Engine.Engine]."

A third solution is to switch to the 64-bit executable, assuming you're running a 64-bit version of Windows and the 32-bit build of *Unreal.* By default, the 64-bit executable utilizes DirectX 9 and wouldn't require you to change the ReduceMouseLag setting. Hopefully, one of these tips gets you back in the game!

Smashing Bottlenecks

Doc, I'm not sure how often you get this question, but is there a resource available to see if your CPU (or entire chipset subsystem) is holding back the GPU? I ask because my friends and I saw Nvidia's GeForce GTX 10-series announcement. Some of us are still rocking older hardware that gets us by for now, and we want to know whether a more substantial upgrade is needed to get the most from these cards.

My system started as a Core i5-2500K on a P67 chipset and a GeForce GTX 570. It was pretty evenly matched at the start of 2011. I upgraded to a GTX 780 at the end of 2013, but suspected the i5-2500K and P67 were holding it back. I can't help thinking that a GeForce GTX 1080 would be crippled by Sandy Bridge. Is that the case?

I'm using the 2500K and GTX 780 to play *Battlefield 4, Fallout 4, GTA V, The Division,* and *Borderlands,* all at 2560x1440. **–Bart E.**

Given the right resolution and settings, a GeForce GTX 1080 will bottleneck any host CPU.

GTX 1080
GTX 1080

THE DOCTOR RESPONDS: Intel's Sandy Bridge was a fantastic architecture, and it remains viable to this day (in fact, the Doc is still using an Ivy Bridge-based Core i7 in his primary gaming system).

A GeForce GTX 1080 has no problem cutting through 2560x1440 on a Skylake-based platform, so it's probable that a Core i5-2500K would indeed

↘ submit your questions to: doctor@maximumpc.com leave performance on the table, particularly in games such as *Battlefield 4* (multiplayer) and *GTA V,* which are known for scaling up on faster host processors. *Borderlands* isn't graphically-intensive, so it'll also likely lean a bit heavier on your CPU than a graphics monster like *Crysis.* That said, a Core i5-2500K should tide you over until you can upgrade the rest of your platform.

Are you overclocking that CPU? If you can take the chip's 3.3GHz base clock rate up to 4.2 or 4.3GHz using capable air or closed-loop liquid cooling, you'll get a lot more performance out of it in CPU-intensive titles. Yes, Intel made incremental improvements to its Ivy Bridge, Haswell, Broadwell, and Skylake designs, but you can compensate for some of those with higher clock rates.

Play at low resolutions using low-quality detail settings, and a GeForce GTX 1080 will bottleneck any host processor. But at QHD and maxed-out quality, you're shifting plenty of load to the graphics subsystem.

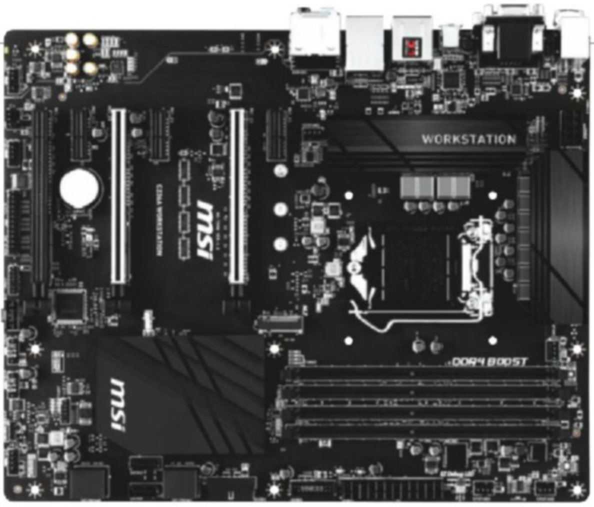
A Success Story

Hiya, Doc! Thanks for the sage advice you gave me in your April issue. I am the guy who wrote in about whether to SLI or not. I followed your advice, and here's the skinny. First, I installed an OCZ 960GB SSD, and my game performance skyrocketed. I'm still whipped. Second, I installed another EVGA GeForce GTX 960 SSC 4GB with an EVGA SLI bridge. Still wettin' my pants. Then I used Turbo Boost overclocking to push my Core i5-4690K to 4.2GHz. Jaw dropped. Last, I added a Corsair H60 to keep that processor comfy and cool.

I have been playing *Star Wars: Battlefront* and *Doom* with absolutely no trouble, and on high-quality settings. This rig of mine is downright satisfying. Thanks again for the guidance!

–Eric Buck

THE DOCTOR RESPONDS: It sounds like you're really well balanced now, Eric. The addition of an SSD is enormous to a PC's responsiveness. And that second graphics card should ensure solid frame rates in even the most taxing graphics workloads. Enjoy!



Keep it professional: MSI's C236A workstation accommodates lots of fast storage and Intel's Xeon E3 CPUs.

Something Special

Hi, Doctor. I'm a 73-year-old PC fanatic who has owned and built more machines than most. That's not bragging, but a fact of reality, because I was in the international arena and had offices in countries that did not have retail stores for computers.

My comfort zone is non-gaming PCs, because I never could understand the draw of games after experiencing first-hand the variables of nature, life, warfare, politics, and so on. Sure, I tried *Doom* and all the off-shoots, but I never really got into them.

Unfortunately, I no longer possess the capacity or knowledge to build my own high-end PC to deal with today's world. But the only high-end PCs I see advertised are gaming machines. This is not an option for me. I need a PC that can hold 40 years of data, and can access it within seconds. Right now, I use Aikin HyperSearch, but it's a bit of a hog on my system.

I also need a PC that can copy and transfer tons of data, while scanning for old-time viruses and Trojans. I lived and worked in Eastern Europe, and my hard drives from those days are infested with bugs. Even my employees, who I hired from Kyiv Polytechnic Institute, would try to infect my computers as a homework assignment.

I also need a computer that can access the Internet in milliseconds, since I do a lot of research. I already have a PhD, but research is my passion. Much of the research I do, though, cannot be accessed by Google, as it's too specialized.

Having given you these criteria, and keeping in mind that I don't want a budget-busting supercomputer, what would you recommend? This question has been bugging me for 10–15 years, yet I've never received a reasonable answer. I just haven't been able to keep up with the advances in technology. Can you help?

–Walter Prochorenko

THE DOCTOR RESPONDS: Because games tend to tax modern hardware more than most other workloads, the highest-end systems tend to be aimed at entertainment. But it sounds like you're describing a compute- and storage-focused PC, without all the fanfare that goes into graphics.

So, consider building on Intel's Xeon E3-1275 v5. This workstation-class host processor is based on the company's newest architecture, Skylake, and operates at 3.6GHz. Its integrated memory controller supports up to 64GB of DDR4-2133 memory with ECC support. And the on-die HD Graphics P530 engine is enabled, so you don't have to worry about a superfluous add-in graphics card. Or, the E3-1245 v5 and -1225 v5 models offer similar functionality, but at lower clock rates and prices.

Buy a motherboard with Intel's C236 chipset, and you'll get plenty of PCIe and USB 3.0 connectivity for attaching fast internal and external storage.

Finally, get your hands on a couple of 1TB-class Intel or Samsung SSDs, along with some magnetic storage in RAID 1, for longer-term archival.

The combination of a fast quad-core CPU, responsive tiered storage subsystem, and professional-grade platform should satisfy all your criteria. You'll have to take care of the snappy Internet on your own, though. May the Doc suggest looking up cities with Google Fiber as potential destinations for blazing-fast connectivity?

SSD Software Support

Hi, Doc. I do a lot of photo and video editing. After many years of coaxing as much performance as I could out of my old rig (first-gen Core i7), I treated myself to a new workstation, and boldly went for an M.2 SSD and 3.5-inch SATA hard drive combo. I let the builder integrate my chosen M.2 SSD to its preferred mobo with Intel's C236 chipset, minimizing compatibility issues. My new SSD is a 512GB PCIe-based SM951 from Samsung.

I learned a great deal about SSDs when I upgraded my old rig from a mechanical disk to a 256GB 840 Pro. For that SSD, Samsung provided its Magician utility, which allowed me to tweak the performance versus lifetime parameters, and so on. But this new M.2 drive includes no such tool. Are new M.2 SSDs so good that no fine-tuning is required, or do I still have a lot to learn? **–Montana Joe**

THE DOCTOR RESPONDS: The lack of software with your SM951 has less to do with its form factor and more to do with the fact that Samsung sells it as an OEM drive. The 950 Pros are out now, and those still come with Magician. Fortunately, Magician's features are available in other utilities.

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Build a Budget VR-Ready PC

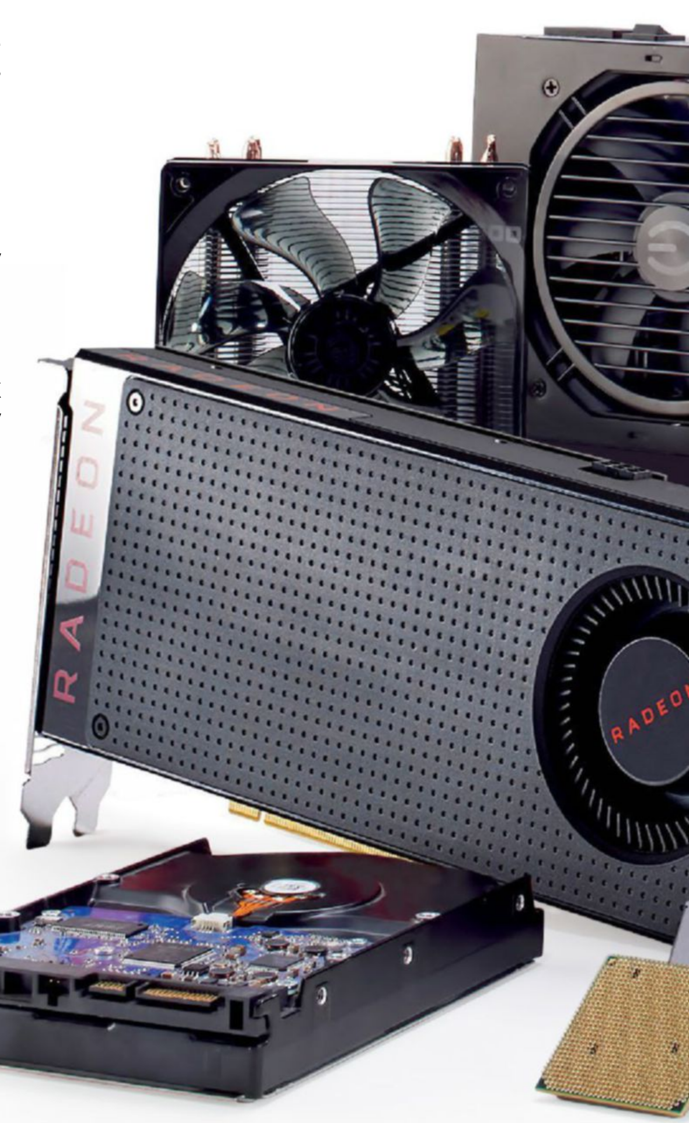
AMD's RX 480's VR claims are put to the test in a $699 rig

BY ZAK STOREY

VIRTUAL REALITY: two words on the tip of the tongue of every tech journalist this side of the Pacific. And with good reason: As far as technological advances go, this is the biggest development in screen technology we've seen since CRT was retired in favor of LCD. But there's one caveat, and it's a big one: the price. It's a heavy commitment—$800 for a headset, and $1,400 or more for a rig capable of powering it. Is it any wonder why we—and the critics—are holding our breath on this one?

What does VR need? In short, more uptake and a lower price point. We now know that there are over 40 separate headsets currently making their way to market, including more affordable—yet still high quality—products from the likes of DeePoon and other manufacturers. This is a huge leap forward, as far as media development is concerned, because it will encourage game developers to create titles specifically for VR, thanks to the increasing user base. So, that just leaves the system....

Let's say, hypothetically speaking, of course, that we're likely to see a headset in the region of $350—could we potentially game comfortably with VR for a little over $1,000 in total? That's what we're hoping to prove with this little build. Centered around AMD's latest 14nm GPU (reviewed on pg. 76), and a budget FX system, we're taking a look at exactly how you would go about building a virtual reality system on a budget.



INGREDIENTS

PART		PRICE
CPU	AMD FX-8320E	$119
CPU Cooler	Cooler Master Hyper 212 EVO	$25
Motherboard	MSI 970 Gaming ATX AM3+	$76
RAM	Corsair Vengeance Pro 16GB (2x 8GB) DDR3 1866 MT/s	$68
OS Storage	Kingston SSDNow V300 Series 120GB 2.5-inch SSD	$39
AD Storage	Hitachi Ultrastar 1TB 7,200rpm HDD	$43
GPU	AMD Radeon RX 480 8GB	$240
Case	BitFenix Neos Black/Red mid-tower ATX	$44
PSU	EVGA 600B 600W PSU (Bronze)	$45
TOTAL		$699

Prices correct at the time of going to press.

CPU

AMD FX-8320E

$119

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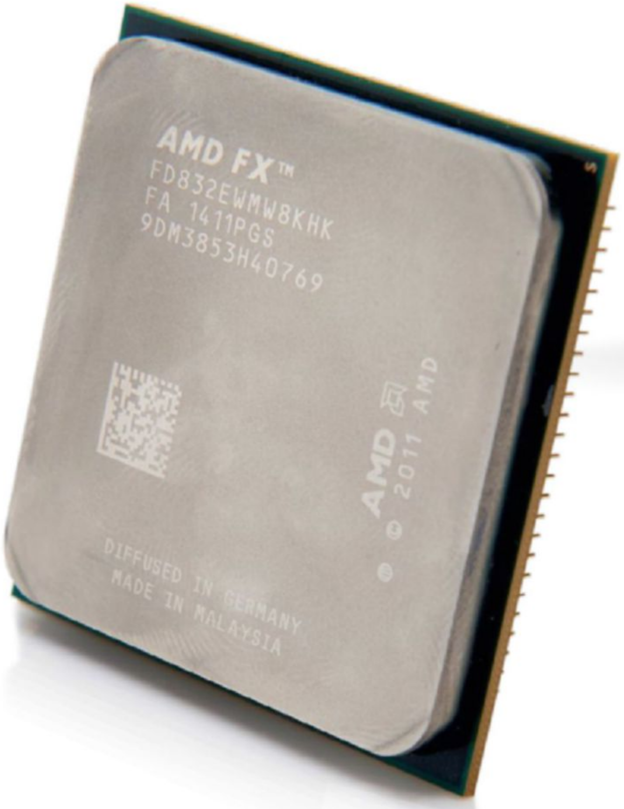
REV B

Historically, AMD has always been the go-to company for budget builds and cheap CPUs. Recently, however, AMD has put more time and effort into developing its Kaveri line. Although boasting relatively impressive integrated graphics, Kaveri lacks a great deal of computational power, enabling Intel to dominate the scene. That said, you can still find yourself a solid AMD gaming CPU, just as long as you're willing to give up native USB 3.0, PCIe 3.0, and additional SATA 6Gb/s functionality for the sake of your budget.

For this build, we settled on an FX-8320E. Despite being an ageing processor, this little beauty's eight cores should be more than enough to drive the latest games at 1080p and beyond. And if DX12's multi-core-loving features are anything to go by, this CPU should be able to pump out some impressive benchmarks later on in its lifetime. The chip comes in at $119, featuring eight cores, running on a base clock of 3.2GHz (turboing up to 4GHz), and offering up support for DDR3 memory up to 2,400MHz on the AM3+ socket. Although not the tsunami of rendering power that you'd find on an Intel chip, the CPU performs admirably for everyday computational tasks.

The alternative solution from Intel would be the Core i5-4460 (it's a budget-friendly Haswell chip.) Its four cores provide very similar performance, but it isn't overclockable, meaning you won't be able to increase those numbers any time soon. Despite this, it does provide PCIe 3.0, more SATA 6Gb/s ports, and native USB 3.0 support, giving it the slight edge when it comes to the feature set.



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READ THE REVIEW PG. 76

GPU

AMD RADEON RX 480 $240

AMD's Radeon RX 480 ruffled some feathers on its way to the top of the value pile. It's a 14nm FinFET card utilizing a single six-pin connector, which at launch saw it drawing more power than the specifications allowed for. A quick driver update sorted this out though, with a nominal drop in performance equating to less than a frame on average in our benchmarks. So all good? We can't help wondering why AMD didn't double-check this on launch, but no real damage done.

That debacle aside, the RX 480 is a stunning card. At the time of writing, it has no equal when it comes to the price to performance ratio. Not even the GeForce GTX 1060 troubles it.

But the real money earner is what AMD is including in the GCN 4.0 architecture. It primarily comes down to a nifty piece of logic embedded into version 4.0, known as Asynchronous Compute with Quick Response Queue, which enables the developer to tell the GPU when to complete a compute task ahead of a graphical one, as opposed to the GPU deciding off the cuff. This is crucial for VR, because it will ultimately reduce latency lag, and that notorious nausea.

RAM

CORSAIR VENGEANCE PRO 16GB $68

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CORSAIR

Memory selection is always slightly controversial. Frequency tends to increase alongside latency, so increasing overclocks actually provides very little in terms of an overall performance increase.

That said, the biggest winner is capacity, and although the FX-8320E at the heart of this little build is hardly the renderer of tomorrow, we opted to go for 16GB of Corsair Vengeance Pro DDR3 memory at 1,866MT/s. That way, there's absolutely no chance of the RAM being the bottleneck, and in theory, we do have the opportunity to upgrade to a Skylake B150 platform later on, without losing much in the way of performance, outside of power savings.

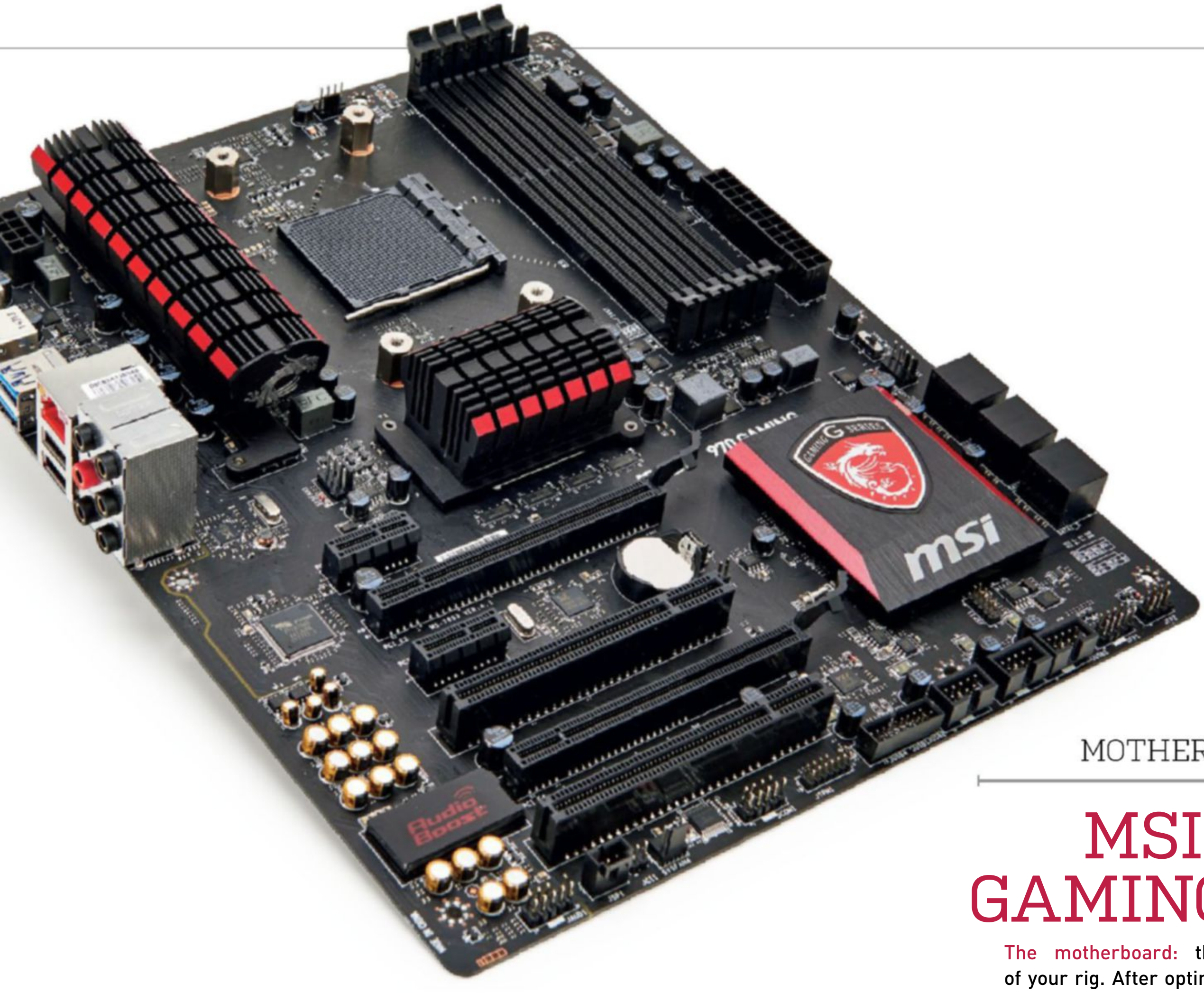
CPU COOLER

COOLER MASTER HYPER 212 EVO $25

Let's be realistic here. The FX-8320E is not a super-fast core, certainly not at stock. So, if we can overclock it, we will. And, quite frankly, even at stock, the retail cooler that AMD ships with the eight-core processor doesn't cope very well with heat. At all. So, with what little budget we had left, we decided to invest in a CPU heatsink worthy of our effort.

Ladies and gents, we give you the Cooler Master Hyper 212 EVO. It's not the best-looking heatsink out there, and it's not the most intuitive to put together. But is it solid and dependable? Yes. Will it keep your beans on ice? Well, probably not. But if you're looking for room temperature, it'll do just fine.

COOLER MASTER



MOTHERBOARD

MSI 970 GAMING $76

The motherboard: the backbone of your rig. After opting for the FX-8320E, we had to find a suitable solution to house all that power. Unfortunately, finding new mobos in AMD's lineup is quite a challenge. It's certainly less simple than with Intel, where each new chip denotes a new chipset.

The MSI 970 Gaming is a fantastic entry-level gaming motherboard. Featuring support for CrossFire and SLI, as well as DDR3 up to 2,133MHz, and a plethora of SATA connectors (at least, for an AMD board), there's no better choice. And guess what! It's black and red.

OS STORAGE

KINGSTON SSDNOW V3 120GB $39

You shouldn't even bother calling yourself a PC enthusiast today if you're not using an SSD for your operating system. The price of flash storage has plummeted over the last couple of years, to the point where you can buy yourself a 120GB Kingston SSDNow V3 for $40. Granted, it'll run a little slower than some of the more premium options out there, but it's a damn sight faster than any HDD, that's for sure.

For additional storage, we threw in a 1TB Hitachi Ultrastar 7,200rpm HDD ($43). This will provide you with plenty of space for all of your games and any additional files you might need to store on your budget build.

CASE

BITFENIX NEOS BLACK/RED

$44

With a $700 budget, it's inevitable that your spec is going to take a hit somewhere. More often than not, this is in the chassis department. For us, the choice was obvious. BitFenix does some fantastic, good-looking, and value-oriented case options. And the BitFenix Neos comes in at just $44, putting us well within our target budget.

This cheap and cheerful chassis is a small, lightweight, and stylish ATX mid-tower. Ideal for our build, it also includes some very intuitive features that you'd not expect to find on a case with such a low price point, such as 2.5-inch and 3.5-inch removable drive bays, the latter of which are tool-less. Additionally, if you fancy chipping in a little extra, you can drop another $10 on the windowed edition, which nets you a red LED BitFenix Spectre fan as well.

PSU

EVGA 600W BRONZE

$45

The power supply will always be one of the trickiest components to choose when it comes to building your first rig. The biggest challenge is finding out how much wattage your lovely new PC is going to utilize, and then allowing for that. Your best bet is to use a calculator. You'll find a fantastic integrated PSU calculator at the top of your selected parts' list at www.pcpartpicker.com.

Ideally, the PSU is one of the components into which you should invest as much as you can. In short, if you buy too cheap a power supply, and it pops, it could easily take one or all of your components with it. Because of this, and our tight budget, we opted for an EVGA 600+ Bronze. Unfortunately, it's non-modular, but it does give us 600W of power and a bronze efficiency rating, which should be more than enough for our AMD build.

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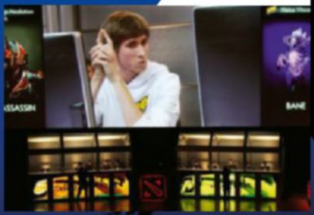

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Time to Get Building

A step-by-step guide to putting your VR-ready PC together

1

PREP FOR YOUR BUILD

IT'LL PROBABLY come as no surprise, but the best way to build a rig is to plan it well. The first and most crucial aspect of creating your new PC is setting up your build area. Make sure that wherever you decide to construct your machine, the area is free from distraction. Ensure you have all the tools you'll need to put your wee beastie together (usually a Phillips screwdriver, some scissors, and a set of needle-nose pliers for the fiddly bits). And, last but not least, try to find a static-free area—avoiding woolly socks and carpets is usually best.

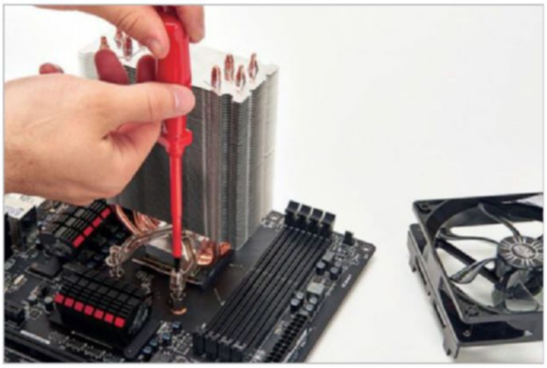
If you're paranoid, you can buy an anti-static strap, but if you can't find one, or are feeling stingy, ensure you regularly touch the casing around a power supply that's plugged into the wall, but powered off. This discharges all the static electricity that you're potentially building up in your body, and may possibly save yourself some heartache later.

2

INSTALL THE CPU AND HEATSINK

START BY BUILDING your PC outside of the case. If any components are dead, it makes it much easier to diagnose and disassemble. The mobo box also acts as a great anti-static test bench. Start with the CPU. Lift the retention arm on the CPU socket on the mobo, and align the FX-8320E with the socket (the golden triangle on one corner of the CPU should match up with the same triangle on the socket). Drop it into place, lower the arm back down, and lock it in.

Now, the heatsink. Secure the backplate with the nuts and bolts. Add a dollop of thermal paste to the middle of the CPU, then carefully position and screw down the heatsink, ensuring the intake of the fan faces the base of the case. Screw the heatsink down in a cross pattern, so you don't put excess pressure on one side of the CPU, potentially bending the pins. Then loop your CPU fan cable around, and plug it into the CPU fan header located above.

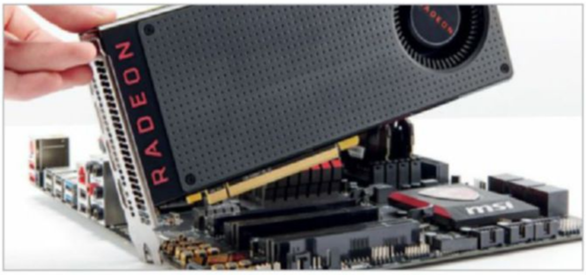


3

ADD THE RAM AND GPU

NEXT IS THE MEMORY. Lift the tabs on either side of the DIMM slots, then line up the RAM, matching the gap in the stick to the notch in the mobo. Push it securely into place. Once you hear a satisfying click, you'll know it's correctly seated. It doesn't really matter which channels you use, but for maximum performance, it's often best to place them one apart (usually color co-ordinated). Also, for this build, you'll want to place them as far away from the heatsink as possible, due to the size of the cooler, while still keeping them in the color co-ordinated channels.

After this comes the graphics card. Gently take your GPU out of its anti-static bag (don't place it on the outside of the bag, as it's conductive, and will discharge all the electricity it's collected). Remove the protective covers on the PCIe connector on the bottom of the card, and gently slot it into the top-most PCIe slot. Usually, we'd advise you not to touch the PCB on the back of the card, but depending on which graphics card you actually use, this may be hidden by a backplate anyway.



4

ATTACH THE MOBO

ONCE YOU'RE CONFIDENT that your new gaming hardware is working, it's time to throw this bad boy into your chassis. First, pull the GPU out of your mobo (simply move the clip located on the PCIe slot upward). Next, unpack your case and remove all the unnecessary components. This means two of the SSD trays can come out, plus two HDD trays, and the little welcome pack of screws. After this, take the rear I/O shield out of your mobo box, and place it into the rear of your case (make sure it's oriented the right way round), and push it into the slot at the back of the chassis, until it clicks into place along the edges.

Next, align your mobo with the pre-installed standoffs, and screw it down. Remove the two corresponding PCIe slot covers on the back of the case, and reinstall your GPU, before securing it with an extra two screws. You'll have to remove BitFenix's ingenious PCIe slot cover—just pull it out, then click it back into place once you're done.

5

PSU AND CABLE MANAGEMENT

NOW FOR THE POWER SUPPLY. Remove the case's side panels, and slide your PSU into the allocated rear slot. Make sure the fan's facing down, so it can pull air from the underside of the case and exhaust it out the back. Push all of the cables through the space in the bottom of the case.

You'll want to plan which cables go where. The CPU's eight-phase power is hardest—pull it up through the uppermost hole. Run it along the top of the mobo, around the RAM, and into the CPU power. The 24-pin power for your mobo can go in the cable-routing hole below the one you've just used for the CPU. Don't force anything, as you'll risk damaging the connector and power supply cable. Then route your front I/O cables around the back, and down into the bottom half of the chassis. Refer to the manual to connect your power/reset buttons and LEDs.

Next, leave three SATA connectors in the rear, and the PCIe power cables in the front. Bundle the remaining cables together with ties, and leave them in the bottom of your chassis.

6

INSTALL THE SSD AND HDD

IT'S NOW TIME to install your hard drives. The BitFenix Neos comes with both 3.5-inch and 2.5-inch drive bays. To install SSDs, pull one of the 2.5-inch drive trays out. Place your SSD inside it (with the connectors facing away from the two finger grips), then secure the drive in place with four screws. Once it's snug, slide the drive back into the cage until it clicks. For the 3.5-inch hard drives, BitFenix has developed an innovative way to secure them. Simply take one of the drive caddies, pull it gently apart, slot the drive in place, and push the caddy back together. Again, with the connectors facing away from the two finger grips.

Now run two SATA cables from the first two ports on the mobo to your drives. Avoid the cable holes, and run them past that panel, around the back of the chassis. Due to the position of the cutout, you won't be able to run the cable through the hole. Then connect the two hard drives using the SATA power connectors we left behind the case earlier.

7

RESEAT THE GPU

NEXT UP, you'll want to reseat the GPU again. Simply line it up once more with the PCIe slot, and press it firmly into place, without using too much force. Try not to bend the connector, or you'll end up snapping it off, and ruining not only your GPU, but your motherboard, too.

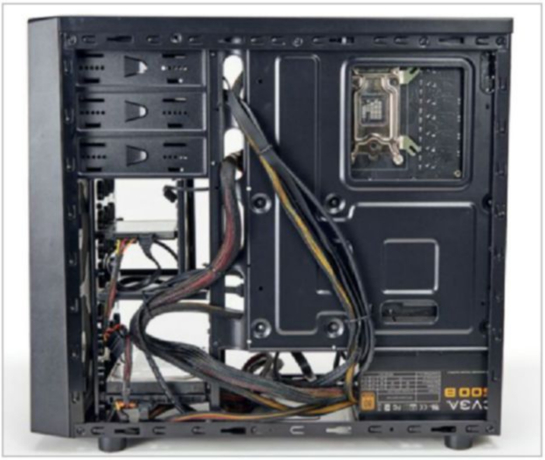
Then run the six-pin PCIe power connector to the card, and install it as you did previously. Additionally, you could use a cable tie here to make sure the PCIe power is nice and cosy. It isn't entirely necessary to cable-tie everything down, but it's always advisable to do it where you can, because it improves airflow and generally looks better. It's also a hell of a lot easier to see what you're doing if you need to make modifications in the future, or if you need to clean out your PC.

8

FRONT I/O CONNECTORS

NOW FOR THE front I/O connectors. The cables should be positioned through the bottom of the chassis. Run the HD audio as far down as you can, along the bottom of the mobo, and into the HD audio connector on the bottom-left.

Next, grab the USB 3.0 cable, and do a similar run. The USB 3.0 connector is on the bottom-middle of the mobo. The USB 2.0 cable can be plugged into the right of the USB 3.0 cable. The front power and reset switches aren't labeled on the mobo, so refer to the manual for the correct positioning of each pin. Then secure the side panels back on the chassis.

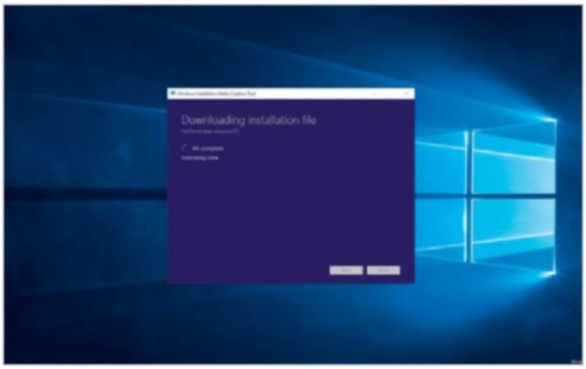


9

INSTALL WINDOWS 10

WE'VE FOUND THAT the best way to install Windows 10 is via a fresh install using a USB stick. Get the ISO via your Microsoft account, then insert a USB stick (8GB is the usual minimum), and use Microsoft's Media Creation Tool to create a bootable disk. The USB stick will be formatted, so make sure any data on there is backed up.

Once you've created your bootable media disk, plug it into a USB 2.0 port at the back of your PC. (If you're running Intel, you should plug it into USB 3.0.) Then boot your PC and make your way to the BIOS. Find the USB stick in the boot order lineup (top of your screen), and drag it to the far-left. Hit F10, save settings, and apply, and let your PC boot into Windows. Once in, you're going to want to jump on to another PC, laptop, or phone, head to http://bit.ly/1TljD0d, and download the Win 10 LAN drivers on to a USB stick. Install them on your rig, update the rest of your drivers, and voila—most of your work is done.



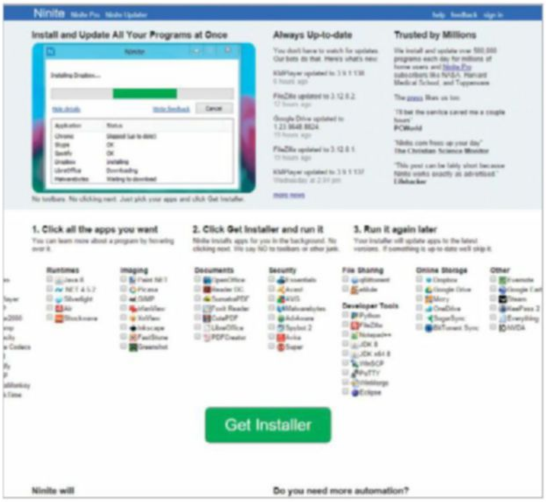
Downloading installation file

10

ADD PROGRAMS

A QUICK AND EASY way to install a lot of commonly used programs is a website called Ninite. It's incredibly straightforward, and something we use almost every day. Head to www.ninite.com, select which programs you want to install, and select "Get Installer."

Ninite then downloads its installer, and automatically installs those programs, ensuring you get the most up-to-date software available. Adware-free, no hidden secrets. (It makes money from a B2B product, so don't worry!) Then it's just a case of installing your more bespoke favorite programs, and you're good to go!



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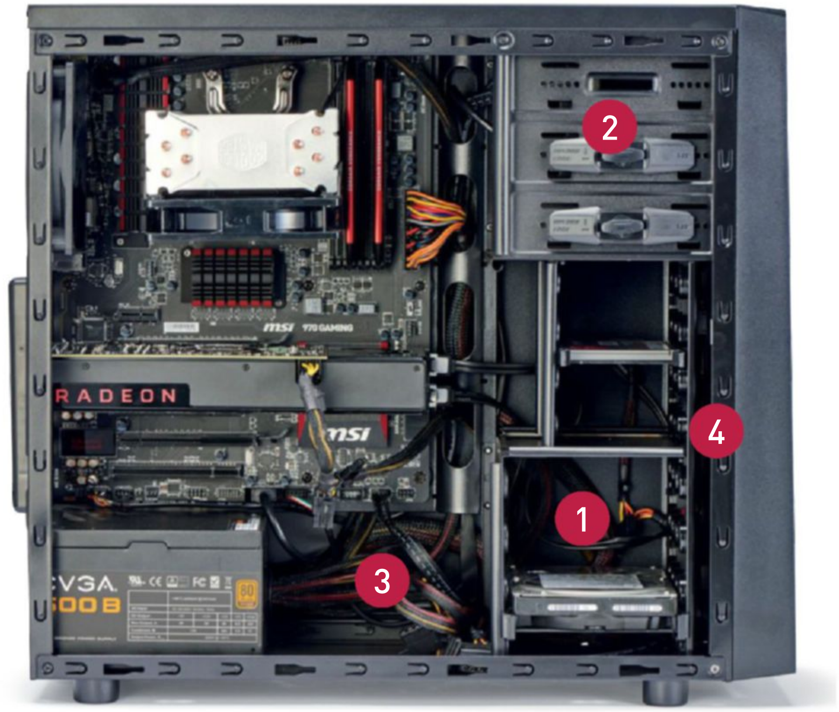

1 The tool-less 3.5-inch bays make it incredibly easy to install any additional hard drives you might have, allowing for a total of three.

2 BitFenix even includes 5.25-inch tool-less bays. If you really do need an optical drive, you could throw one in here with relative ease.

3 A modular power supply would have been nice here, but the EVGA 600B is brilliant value, and comes with a great warranty.

4 The Neos also has support for two 120mm fans in the front of the chassis, which is ideal for a hot system, like this one.

GAME ON

SO, WE COME TO the big question—the one on everyone's lips: Does this machine meet the VR-ready specification? Has the impossible been achieved? Has Polaris and the 14nm manufacturing process finally made budget VR possible? Can we keep asking rhetorical questions that you can't answer as a way of building the suspense?

The answer is yes, to all of them. Not by a foot, but by a mile. In Steam's VR Performance Test, our AMD budget build scored an absolutely astonishing 6.6, bringing it nicely into the green bar, well beyond the "capable" segment, and into VR-ready. And all for a touch less than $700, too. Apart from that, in-game performance was, relatively speaking, for the price, quite incredible. Both *Far Cry Primal* and *The Division* scored well into the fifties for average frame rate, and *Rise of the Tomb Raider* scored a respectable 35fps with everything ramped up—a title that's notorious for hammering down our frame rates in testing. What is interesting, though, is that despite AMD's continued development with DirectX 12, *ROTTR* actually averaged 4fps lower than DX11, indicating that Piledriver's low overall single-core performance may have something to do with it.

Computational performance, on the other hand, was a far sadder story. In CineBench, we saw a respectable 507 points, but taking a quick look at single-threaded performance saw an astronomically low 90 points, almost 100 points lower than last issue's Intel Core i5-6600K. On top of that, SSD performance was a little lackluster. Although the Kingston SSDNow V3's read speeds were well up at 511MB/s, the writes didn't fair so well, scoring 105MB/s

The overall build process was fairly smooth. Obviously, at this price point, it's never going to run completely smoothly—after all, we're talking about a $44 chassis and a non-modular PSU. Something to take note of is definitely a lack of length in the EPS power. It was quite a squeeze to thread it through the back of the chassis, then up, and in—you could potentially get around this by using an extender, but then it's a case of breaking the budget a fraction more. Also, the Cooler Master Hyper 212 Evo CPU heatsink, once configured correctly, was an absolute pain. Not particularly difficult to install, just annoying.

Ultimately, this system is ideal for those looking to build themselves a nice little niche gaming PC, solely to be used at 1080p, and for general office work. It's not a rendering powerhouse, or some monster of solid-state performance, but a perfect gaming rig. ⏻

BENCHMARKS

CineBench R15 Single	90
CineBench R15 Multi	507
TechARP x264	11.98fps
CrystalDisk Sequential Read	511MB/s
CrystalDisk Sequential Write	105MB/s
CrystalDisk Random 4K Read	21.94MB/s
CrystalDisk Random 4K Write	83.66MB/s
PCMark 8 Creative (Accelerated)	5,380
3DMark Fire Strike	7,835
Rise of the Tomb Raider	35fps
Far Cry Primal	53fps
The Division	57fps

All games are tested on the ultra preset, with HD texture packages, and antialiasing set to the maximum possible. All frame rates are averages.

BUDGET VR BENCHMARKS

	AMD Budget Build	Zero-Point Machine
Steam VR Performance Test	6.6	**9.6**
Price	**$699**	$2,275

Zero-point machine based on cheapest possible configuration. Best scores in bold.

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- 256GB SanDisk X400 M.2 SSD + 1TB 7200RPM Hard Drive
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- Hardware Raid 0,1 Function capable
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- 30 days No Dead Pixel Guaranteed Insurance
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- 16GB Dual Channel DDR4-2400MHz Memory
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- 8GB DDR5 NVIDIA® GeForce™ GTX 1070 GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 256GB SanDisk X400 M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives Capable with Raid 0,1 Function
- Full sized Keyboard with color LED backlight
- Intel® Dual Band Wireless-AC 8260 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Built-in speakers and a sub-woofer
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- Windows® 10 Home 64-bit Edition
- 15.6" Full HD IPS Matte Display (1920x1080) with NVIDIA® G-SYNC Technology
- 30 days No Dead Pixel Guaranteed Insurance
- 6GB DDR5 NVIDIA® GeForce™ GTX 1060 GPU
- 8GB DDR4-2133MHz Memory
- 256GB SanDisk X400 M.2 SSD + 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives Capable with Raid 0,1 Function
- Full sized Keyboard with color LED backlight
- Intel® Dual Band Wireless-AC 8260 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 25mm /0.98 inch thin

NP8172 Notebook
$1,299

After $50 Instant Savings

- 6th Generation Intel® Core™ i7-6700HQ Processor (6MB Smart Cache, 2.60GHz)
- Windows® 10 Home 64-bit Edition
- 17.3" Full HD Matte Display (1920x1080) (NVIDIA® G-SYNC Technology optional)
- 6GB DDR5 NVIDIA® GeForce™ GTX 1060 GPU
- 8GB DDR4-2133MHz Memory
- 1TB 7200RPM Hard Drive
- 2 Hard Drives + 2 M.2 SATA SSD Drives Capable with Raid 0,1 Function
- Full sized Keyboard with color LED backlight
- Intel® Dual Band Wireless-AC 8260 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
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- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 1.18 inch thin

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- Built-in 2.0M FHD Camera & Fingerprint Reader

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MAKE YOURSELF HACK-PROOF

Make your PC more resilient to hackers and malware, with some help from *Nick Peers*

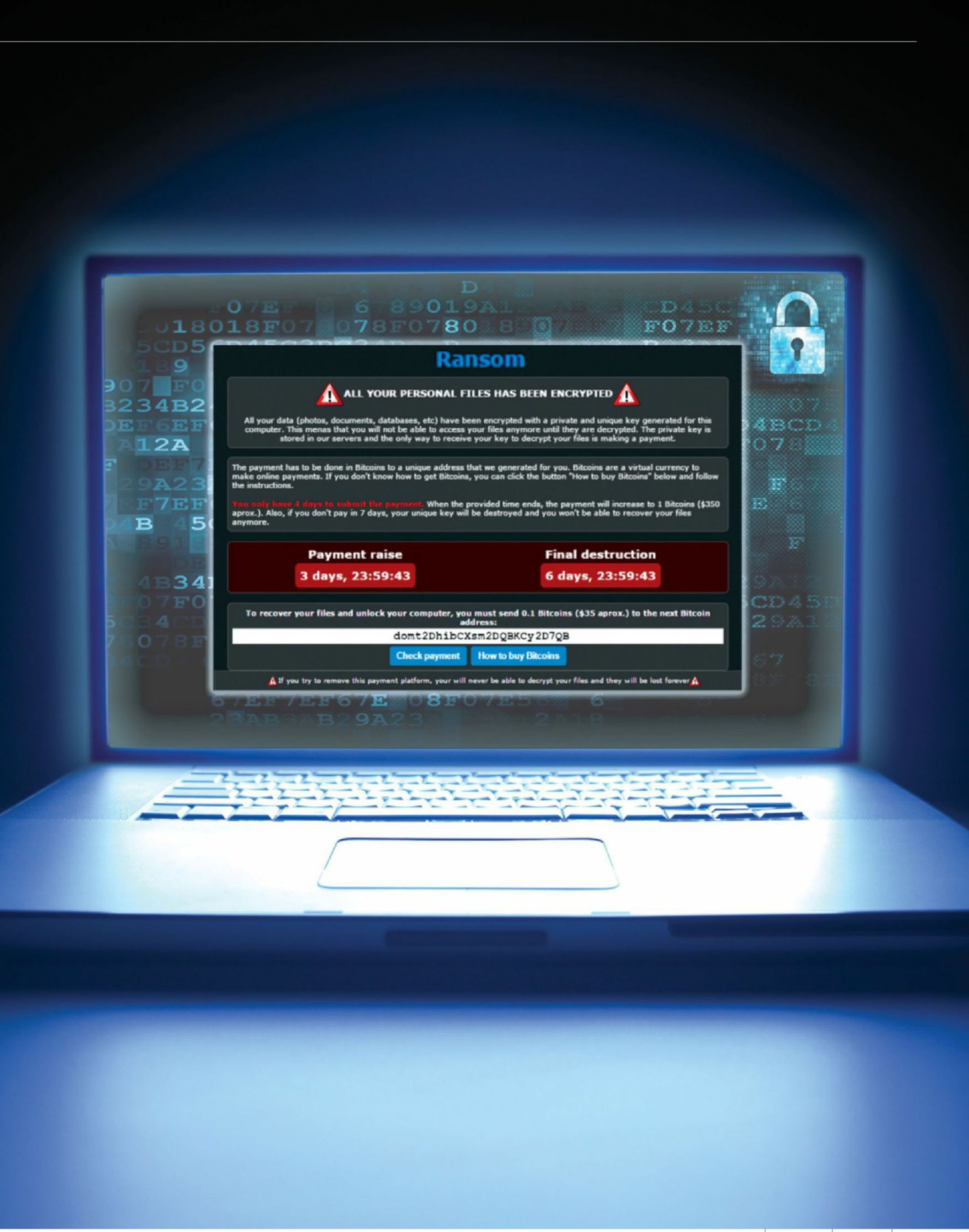
ONCE UPON A TIME, the act of protecting your PC against viruses was simply to install an antivirus program, and watch what floppy disks and CD-ROMs you introduced to it. Then we all got Internet access, and you needed to make sure you didn't download anything dodgy, while introducing a firewall to dissuade drive-by hackers. And for a while, that seemed sufficient.

How times have changed—and with ever-increasing rapidity, too. Nowadays, the threats keep coming, finding ever more inventive ways of getting through defenses, using trickery as much as anything else. But however hard the hackers fight, the security folk fight back, helping develop new forms of protection, removal, and repair to thwart the cybercriminals.

As it was in the beginning, prevention is always better than cure. Far better to tighten the security on your PC than have to go through the trauma of removing unwanted software, or battling a demand for thousands of dollars from a ransomware attack. But where do you begin? What software do you need? And how can you change your behavior to minimize your exposure in the first place? In this feature, we'll help you on all these counts.

We'll reveal the core protection you need, plus run through the various ways in which your online activities put you at risk, and how to protect yourself accordingly. You'll discover how to encrypt your email, properly screen downloads for viruses and potentially unwanted programs, keep malvertising at arm's length, and ensure none of your online accounts are easily—if at all—hacked. We'll help secure your home network, too, so people can't piggyback on to your Wi-Fi, or gain access to your home devices through your router.

And what happens if you do get infected? Don't worry—we'll run through some ways in which you can wrest control of your PC back from the malware, plus point you in the direction of some useful tools that can help you recover from a ransomware attack, even to the point of potentially decrypting your precious data. Without further ado, let's get this (anti-malware) party started!



Ransom

ALL YOUR PERSONAL FILES HAS BEEN ENCRYPTED

All your data (photos, documents, databases, etc) have been encrypted with a private and unique key generated for this computer. This menas that you will not be able to access your files anymore until they are decrypted. The private key is stored in our servers and the only way to receive your key to decrypt your files is making a payment.

The payment has to be done in Bitcoins to a unique address that we generated for you. Bitcoins are a virtual currency to make online payments. If you don't know how to get Bitcoins, you can click the button "How to buy Bitcoins" below and follow the instructions.

You only have 4 days to submit the payment. When the provided time ends, the payment will increase to 1 Bitcoins ($350 aprox.). Also, if you don't pay in 7 days, your unique key will be destroyed and you won't be able to recover your files anymore.

Payment raise

3 days, 23:59:43

Final destruction

6 days, 23:59:43

To recover your files and unlock your computer, you must send 0.1 Bitcoins ($35 aprox.) to the next Bitcoin address:

domt2DhibCXsm2DQBKCy2D7QB

⚠ If you try to remove this payment platform, your will never be able to decrypt your files and they will be lost forever ⚠

IT GOES WITHOUT SAYING that you need anti-malware software. Windows 10 comes with Windows Defender for basic protection, but it's outclassed by most other anti-malware tools. The best free antivirus tools include BitDefender AV Free (www.bitdefender.com/solutions/free.html) and Panda Free AntiVirus (www.pandasecurity.com). However, if you're looking for more comprehensive security (including a third-party firewall), ESET Smart Security (www.eset.com/us) is renowned, along with Kaspersky (www.kaspersky.com), while we've personally relied on Norton Security (www.norton.com) for the past nine years.

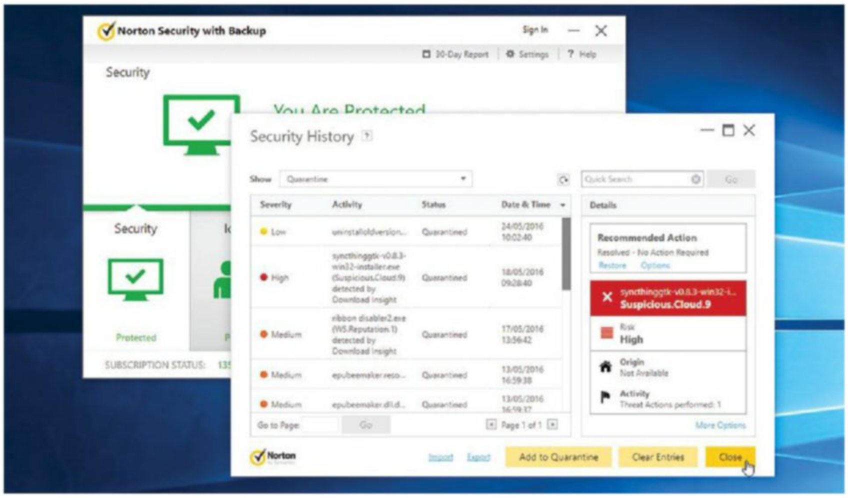
In the past, you could only run one antivirus app on your PC at once. These days, there exist anti-malware apps designed to work in tandem with other security software. The most visible is Malwarebytes Anti-Malware (www.malwarebytes.org). The free version provides scan and remove tools, but for continuous real-time protection, and the ability to block malicious websites—vital when it comes to keeping out malvertising and potentially unwanted programs (PUPs)—the Professional Edition costs $24.95 per year. Speaking of PUPs, it's worth installing a tiny, free program called Unchecky (www.unchecky.com) to keep unwanted add-ons off your PC.

TIGHTEN UP YOUR ROUTER

One of the most effective ways of making your PC as hacker-proof as possible is to review the way you use your PC. Let's begin by securing your PC's connection to your network and the Internet. First, your network: If you connect through Wi-Fi, make sure you have WPA2 encryption enabled in your router's settings, and choose a strong, randomly generated password that can't easily be remembered, if at all (write it down, and store it somewhere secure).

Worried about drive-by hackings, where people get within range of your wireless network, then attempt to gain access to it? Reduce your network's visibility by disabling SSID Broadcast, then changing the SSID of your network to a name that's not easy to guess. If you're truly paranoid, enable wireless MAC filtering (use the "ipconfig /all" command in a Command Prompt window to find out your PC's MAC address, in order to whitelist it first), change your network's IP address from the usual 192.168.0.x to 192.168.y.x (where "y" is between 1 and 255), and disable DHCP.

With these settings in place, a hacker would need four things to gain access: first, your network SSID and its password. They'd also need to know a MAC address to spoof, and know what IP address to assign to their device (as well as the IP address of your router), just to get on your network. In


Norton Security with Backup
Sign In
30-Day Report
Settings
Help
Security
You Are Protected
Security
Protected
SUBSCRIPTION STATUS:
Security History
Show
Quarantine
Quick Search
Go
Details
Recommended Action
Resolved - No Action Required
Restore
Options
syncthinggtk-v0.8.3-win32-i...
Suspicious.Cloud.9
Risk
High
Origin
Not Available
Activity
Threat Actions performed: 1
More Options
Go to Page:
Go
Page 1 of 1
Norton
Import
Export
Add to Quarantine
Clear Entries
Close

Severity	Activity	Status	Date & Time
Low	uninstalloldversion...	Quarantined	24/05/2016 10:02:40
High	syncthinggtk-v0.8.3-win32-installer.exe (Suspicious.Cloud.9) detected by Download Insight	Quarantined	18/05/2016 09:28:40
Medium	ribbon disabler2.exe (WS.Reputation.1) detected by Download Insight	Quarantined	17/05/2016 13:56:42
Medium	epubeemaker.reso...	Quarantined	13/05/2016 16:59:38
Medium	epubeemaker.dll.d...	Quarantined	13/05/2016 16:59:37

Norton provides comprehensive protection for your computer.

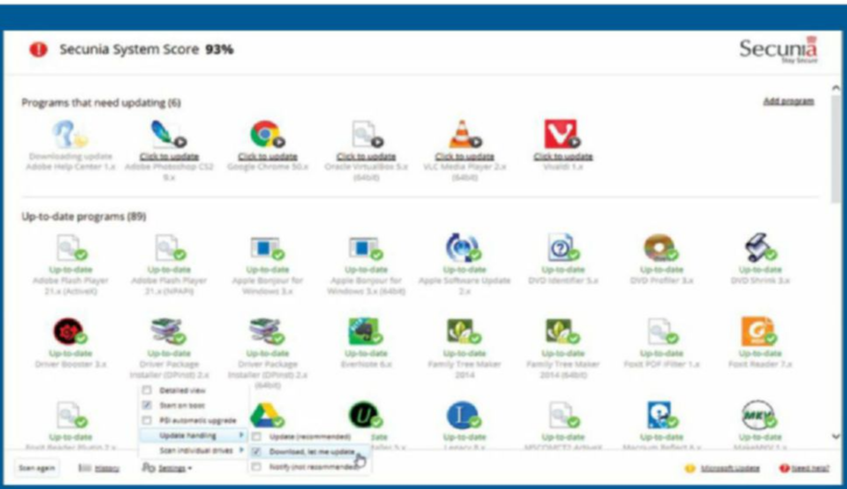
THE IMPORTANCE OF BEING UPDATED

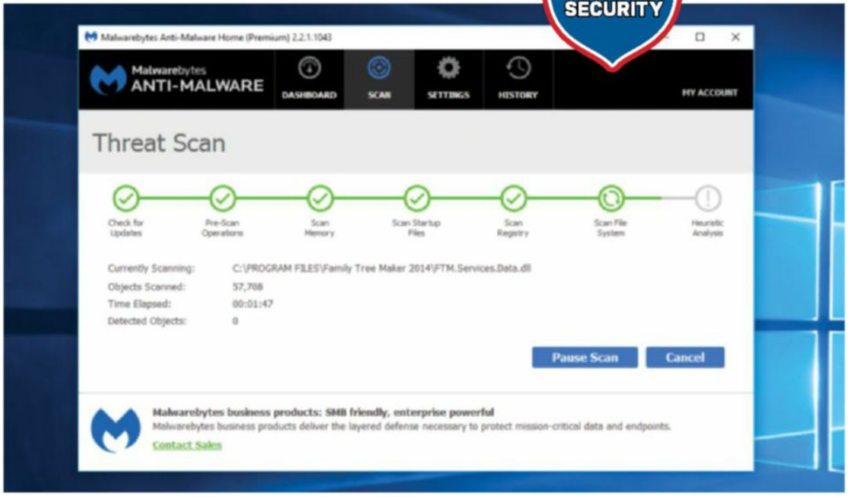
Hackers are always looking for weak spots to exploit, and often find them in the underlying code that makes up Windows and all the programs (and associated extras, such as browser add-ons) on your PC. When vulnerabilities are found, hackers use "zero-day exploits" to take advantage of them.

Most good anti-malware software has built-in behavioral protection against these exploits—it works by monitoring your PC's processes for suspicious behavior that could point toward a zero-day attack, and takes steps to block it. It's not foolproof, though—some false positives can be found, and other exploits can go unnoticed.

As always, the best form of protection is prevention, and that means keeping your system up to date. It's one of the reasons why Windows 10 now forces its updates down your throat, and most good software automatically checks for new versions when it's first launched—never skip this, particularly if its changelog refers to security updates. Most browser add-ons should update automatically, too, but Flash is one you should keep an eye on – it's more vulnerable than most to zero-day exploits, and given the rise in support for native HTML5 video streaming, you might want to experiment with disabling it altogether. (In Firefox, go to "about:addons," select "Plugins," and set Shockwave Flash to "Ask to Activate"—that way, you're alerted when a site needs it, enabling you to make an informed decision on whether to run it.)

If you're struggling to keep your programs updated, use a free tool called Personal Software Inspector (http://bit.ly/softinspector), which carries a database of thousands of supported apps, and tells you exactly which ones need updating at any given time—in many cases, it can even do the updating for you.


Secunia System Score 93%
Secunia
Programs that need updating (6)
Add program
Downloading update
Adobe Help Center 1.x
Click to update
Adobe Photoshop CS2 9.x
Click to update
Google Chrome 50.x
Click to update
Oracle VirtualBox 5.x (64bit)
Click to update
VLC Media Player 2.x (64bit)
Click to update
Vivaldi 1.x
Up-to-date programs (89)
Up-to-date
Adobe Flash Player 21.x (ActiveX)
Adobe Flash Player 21.x (NPAPI)
Apple Bonjour for Windows 3.x
Apple Bonjour for Windows 3.x (64bit)
Apple Software Update 2.x
DVD Identifier 5.x
DVD Profiler 3.x
DVD Shrink 3.x
Driver Booster 3.x
Driver Package Installer (DPInst) 2.x
Driver Package Installer (DPInst) 2.x (64bit)
Evernote 6.x
Family Tree Maker 2014
Family Tree Maker 2014 (64bit)
Foxit PDF IFilter 1.x
Foxit Reader 7.x
☐ Detailed view
☑ Start on boot
☐ PSI automatic upgrade
Update handling
Scan individual drives
☐ Update (recommended)
☑ Download, let me update
☐ Notify (not recommended)
Scan again
History
Settings
Microsoft Update
Need help?



Currently Scanning: C:\PROGRAM FILES\Family Tree Maker 2014\FTM.Services.Data.dll
Objects Scanned: 57,708
Time Elapsed: 00:01:47
Detected Objects: 0

Malwarebytes business products: SMB friendly, enterprise powerful
Malwarebytes business products deliver the layered defense necessary to protect mission-critical data and endpoints.

Malwarebytes Premium blocks threats that are often missed by other tools.

reality, this will make network setup long-winded, so you may want to strike a balance (perhaps leave DHCP enabled, for example).

Next, tighten your router's other settings. Verify its firewall is switched on, and review any ports you're forwarding—these are channels from the Internet to your networked devices, so make a note of what they are, remove any not in use, and disable those you don't need permanent access to. Also, review your UPnP settings—these ports are dynamically allocated to applications running on your network. Disable any suspicious ones, and search for the originating apps to remove them.

It's also important to protect access to the router's settings: Change the default password to a stronger one (change the username if allowed, too), and look for a Remote Management or Remote Access option. This latter setting enables you (and anyone else) to access your router from outside your home network, using your public IP address (or dynamic hostname, if you have one). Disable this setting.

LOCK DOWN YOUR NET CONNECTION

Virtual private networks (VPNs) offer a number of security and privacy features—not only can you anonymize yourself and your location when connected through one, but they also encrypt all your Internet traffic, which makes them an essential add-on for your laptop or tablet when surfing a public, unencrypted Wi-Fi hotspot.

There are many free services, such as CyberGhost (www.cyberghostvpn.com), but these come with limits—CyberGhost's only limitation is the speed of your connection, which is noticeably slower. Paid-for plans, starting from around $6/month, lift this limit, and there's no wait before you connect.

If you'd like to run your entire home network through a VPN, you need to use a second router that supports the DD-WRT firmware—check out www.techradar.com/1300740 for a complete guide.

BEHAVIORAL CHANGES

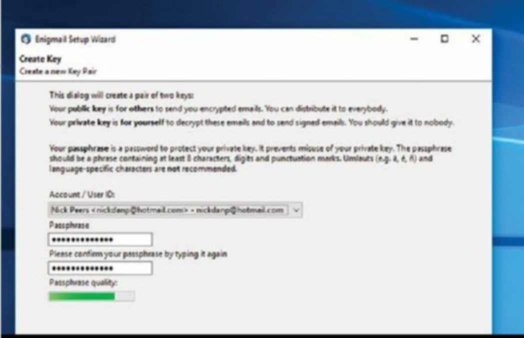
Unfortunately, gone are the days when the only way malware got on to your system was through opening files or programs; these days, many threats are triggered by your own behavior, through misdirection.

So, how can you protect yourself from—er—yourself? Let's start with email, where most of the initial phishing originated. First, treat all email with suspicion. If it's peddling an offer too good to refuse, or making dire threats while exhorting you to click a link to verify your account or respond to some kind of dispute or offer, just take a deep breath. Re-read the message, spot the spelling mistakes, or the fact the address you've been emailed isn't the one you've linked to your bank account. Who's the sender? In the vast majority of cases, these basic checks will reveal that the email is a fraud.

Get into the habit of never clicking links in emails. Instead, open your browser, and visit the site specified by typing its address. But that's not all you need to do against emails. Some contain malicious code hidden in the mail's HTML, so configure your email client to read mail in plain text by default. Also, consider installing a mail-checking tool, such as POP Peeper (www.esumsoft.com) or Mailwasher (www.mailwasher.net), which can screen mail for junk and scams, and let you preview email without downloading it. Connect using SSL or TLS (see the "Encrypt Your Email" box).

SAFER WEB SURFING

In the past, surfing the web was a blind process—you typed in a web address and it loaded, no matter what was lurking at the other end. These days, most browsers



This dialog will create a pair of two keys:
Your **public key** is **for others** to send you encrypted emails. You can distribute it to everybody.
Your **private key** is **for yourself** to decrypt these emails and to send signed emails. You should give it to nobody.

Your **passphrase** is a password to protect your private key. It prevents misuse of your private key. The passphrase should be a phrase containing at least 8 characters, digits and punctuation marks. Umlauts (e.g. ä, é, ñ) and language-specific characters are **not** recommended.

Account / User ID: Nick Peers <nickdanp@hotmail.com> - nickdanp@hotmail.com
Passphrase: ••••••••••••••
Please confirm your passphrase by typing it again: ••••••••••••••
Passphrase quality:

Encrypt Your Email

Make sure your email provider supports secure methods for sending and receiving email—for webmail providers, that means ensuring you're always logging on through https:// to prevent your password being sniffed out by hackers. In the case of major providers such as Google, this should now be the default, but also look for other ways in which to protect your account—see the "Protect Online Accounts" box over the page.

If you use a traditional email account, check with your provider that it supports SSL, and verify you're using those settings in your mail program to send and receive messages. This ensures your password and the content of your emails are encrypted when sent to or received from the server.

As things stand, however, the content of your email isn't encrypted during transit, and is easily readable. If your mail provider supports TLS, it's possible to encrypt emails you send to and receive from other email providers that also support TLS. Taking Gmail as an example, the feature is enabled by default, but look for an open red padlock when composing emails—this indicates that the receiver doesn't support TLS, so the conversation won't be encrypted. Otherwise, check with your email provider to see if TLS is supported, and what settings you need to apply in your client—plus check to see if it's able to make it clear which conversations are encrypted, and which aren't.

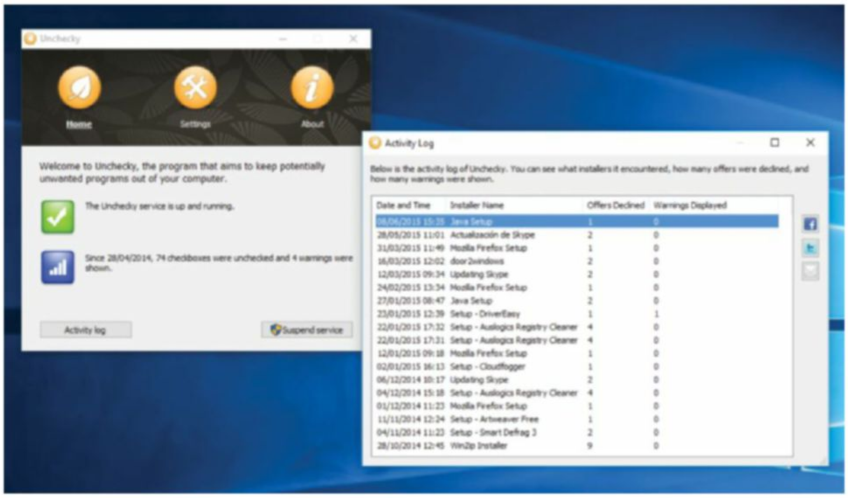
TLS isn't a silver bullet, so if you want to go further (with co-operation from other individuals), look at implementing PGP mail encryption. This encrypts the mail before it's sent, and then the recipient uses PGP at their end to decrypt the mail once it arrives. Wizards make it relatively easy to set up, but Google your email client (or webmail provider) and "pgp" to find out more.

Protect Online Accounts

One of the biggest contradictions with passwords is that they need to be unique, strong, and hard to crack, yet somehow easy to remember. Thankfully, password managers are built specifically to aid with this process—you set up a vault containing all your passwords, then unlock it with one master password, ensuring you only need to remember that to effectively gain access to all the rest.

Our favorite password manager is LastPass. We recommend the Premium version ($12 a year), which syncs across all your devices (mobile and desktop), and offers two-factor authentication, as well, which means that even if someone hacks your password, they still can't get at your vault. LastPass is installed as a browser add-on or standalone app, and offers to save passwords as you enter them for the first time. It can also generate strong, randomly generated passwords for sites, and thanks to its Security Challenge, can then alert you to weak and duplicate passwords that need changing, as well as highlight sites that have been the victim of attacks. In some cases, it can even automatically change these passwords for you with a single click—though, generally, you need to change them manually.

But LastPass itself was hacked, we hear you cry. And therein lies the rub: These days, it seems major websites will at some point be subject to attack. The question is, how robust are the site's defenses? In the case of LastPass, it did give up user email addresses, but nothing else was lost—LastPass has no access to your master password anyway, while the encrypted vaults were left untouched. LastPass then immediately enabled email verification, which meant any hacker logging on from an unknown location who guessed your password would still be blocked, while you would have received an email notification, giving you time to change your password.



Welcome to Unchecky, the program that aims to keep potentially unwanted programs out of your computer.

The Unchecky service is up and running.

Since 28/04/2014, 74 checkboxes were unchecked and 4 warnings were shown.

Below is the activity log of Unchecky. You can see what installers it encountered, how many offers were declined, and how many warnings were shown.

Date and Time	Installer Name	Offers Declined	Warnings Displayed
08/06/2015 15:35	Java Setup	1	0
28/05/2015 11:01	Actualización de Skype	2	0
31/03/2015 11:49	Mozilla Firefox Setup	1	0
16/03/2015 12:02	door2windows	2	0
12/03/2015 09:34	Updating Skype	2	0
24/02/2015 13:34	Mozilla Firefox Setup	1	0
27/01/2015 08:47	Java Setup	2	0
23/01/2015 12:39	Setup - DriverEasy	1	1
22/01/2015 17:32	Setup - Auslogics Registry Cleaner	4	0
22/01/2015 17:31	Setup - Auslogics Registry Cleaner	4	0
12/01/2015 09:18	Mozilla Firefox Setup	1	0
02/01/2015 16:13	Setup - Cloudfogger	1	0
06/12/2014 10:17	Updating Skype	2	0
04/12/2014 15:18	Setup - Auslogics Registry Cleaner	4	0
01/12/2014 11:23	Mozilla Firefox Setup	1	0
11/11/2014 12:24	Setup - Artweaver Free	1	0
04/11/2014 11:23	Setup - Smart Defrag 3	2	0
28/10/2014 12:45	Win2p Installer	9	0

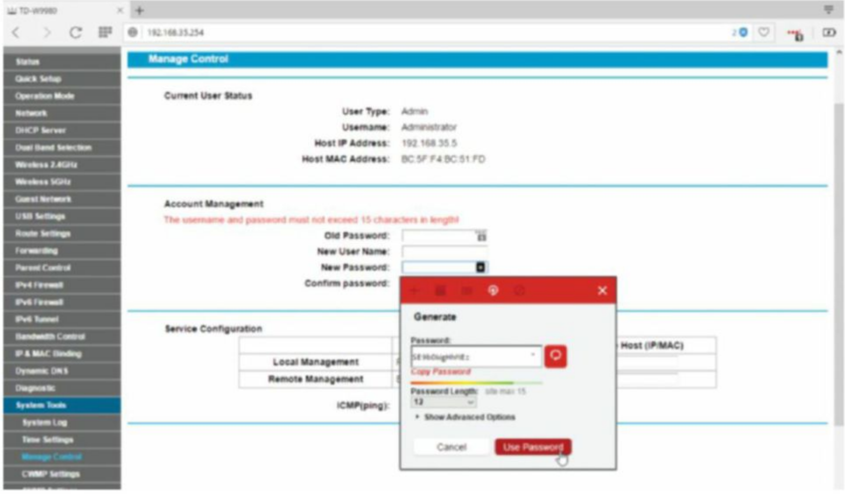
You can block unwanted program installations with Unchecky's help.

can detect known malicious websites, and block them by default, but there are still many dodgy sites that aren't considered direct security risks. This is where web filtering solutions, such as Web of Trust (www.mywot.com), come in. WOT operates a traffic-light safety system, providing an icon next to web addresses (and search results) that's green (safe), amber (use with caution), red (dangerous), or gray (untested, so be cautious). The ratings are community-based, so aren't always 100 percent accurate, but they do help flag up potentially dangerous sites, and block access to red-rated sites by default. Add-ons are available for all major browsers. Norton offers a similar feature with Safe Web, which is included as part of its Identity Safe password-management tool.

Even with this extra line of defense, protecting yourself on the web requires extra effort. First, adopt the same level of scepticism to everything you see on the web as you do with email. Phishing occurs across all platforms, from pop-up pages masquerading as Windows dialog boxes, claiming you've been infected or need to update now, to scams in Facebook Messenger, trying on the same type of scam as found in email. You should even be suspicious of text messages exhorting you to share your two-factor authentication code "for security purposes."

First, don't react immediately. Neither should you try to close the window, unless you're confident that what you're clicking is the close window dialog box, and not a spoofed one. Instead, use Task Manager to close the process. Under no circumstances give out any personal data, regardless of who is apparently asking for it.

Another way to tighten web surfing is to use a secure web connection (https://) whenever you can. Some sites automatically use secure connections, but others don't—even though they support them. Force all compliant sites to encrypt your connection by installing the HTTPS Everywhere add-on



Manage Control

Current User Status

User Type: Admin
Username: Administrator
Host IP Address: 192.168.35.5
Host MAC Address: BC:5F:F4:BC:51:FD

Account Management

The username and password must not exceed 15 characters in length!

Old Password:
New User Name:
New Password:
Confirm password:

Service Configuration

Local Management
Remote Management
Host (IP/MAC)
ICMP(ping):

Password Length: site max 15
12

Make sure you tighten your network's security through your router.

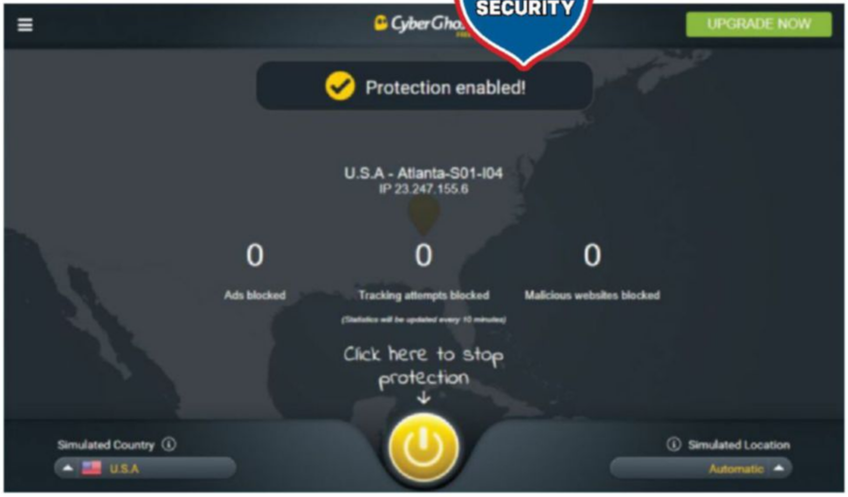
for Chrome, Firefox, and Opera (www.eff.org/HTTPS-everywhere).

MALICIOUS ADD-ONS

Browser add-ons such as WOT and HTTPS Everywhere help tighten browser security, but it isn't surprising that not all add-ons are what they seem, with many able to track your movements and steal personal data. Malicious add-ons have been injected into the Chrome Web Store in the past, while some cybercriminals buy up legitimate add-ons, only to introduce nasties through updates, which are automatically installed. Even those add-ons that appear to be reputable can sometimes be poorly coded in such a way as to make them vulnerable to exploits.

First, exercise extreme caution before installing any add-on—do all the usual checks, such as checking who the publisher is, and reading reviews (and paying particular attention to any that allege the add-on is spyware or spam). Google the name and words such as "malware" or "exploit," to see if they're linked in any way. Check the permissions (particularly during an update, where an add-on may ask for additional permissions it didn't previously need), and ask yourself why it wants them. Also, regularly check your browser extensions, removing any you no longer need or don't recognize.

Consider using bookmarklets, too, instead of add-ons—bookmarklets contain tiny bits of code that do simple things, such as tweeting the current page, but they can't automatically update, and only run when you click the bookmarklet. Again, be sure to obtain these from reputable sources, and be as sceptical as you would with an add-on.


CyberGho
UPGRADE NOW
Protection enabled!
U.S.A - Atlanta-S01-I04
IP 23.247.155.6
0
Ads blocked
0
Tracking attempts blocked
0
Malicious websites blocked
Click here to stop protection
Simulated Country
U.S.A
Simulated Location
Automatic

Free VPNs might be slow, but they are safer than regular connections.

DOWNLOAD PROTECTION

Downloads are a common source of malware, so make sure the installer is scanned by your anti-malware tools before you launch it—right-click the file to find the relevant option, such as "Scan with Malwarebytes Anti-Malware," if it's not done automatically (Norton pops up a message in the Taskbar Notification area to tell you it's scanning the file, for example).

An increasing number of developers provide checksums for the software you've just downloaded. These checksums, also known as signatures or hashes, are typically used to verify a download isn't corrupt, but can also be used to calculate its authenticity, too. You need a third-party tool to generate the "hash" of the file you've downloaded, then you compare this with the checksum given online—it's not definitive proof, but it's a useful extra step.

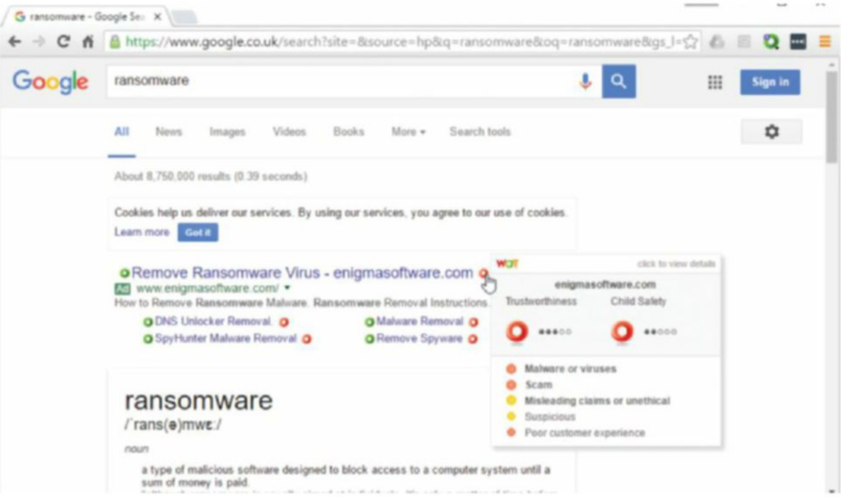
There's a number of different hashes used: MD5 and SHA are the most common, and the MD5 & SHA Checksum Utility (https://raylin.wordpress.com/) makes it easy to verify either type. Just select your downloaded file, then paste in the hash from the webpage, and click "Verify"—the program quickly confirms the two match.

There's one major development to look out for when downloading software. An increasing amount is shipped as "bundleware," which means it includes other program installers, offered to you during installation. Reputable installers make these offers crystal clear, and make it obvious how to opt out of them, but an increasing number don't, making it all too easy to accidentally install unwanted extras, not all of which are desirable.

It's not just individual programs, either—major download sites (we're looking at you, Download.com) have also started bundling extra unwanted software with downloads, and some of this is little more than "crapware," or even borderline malware. In the case of Download.com, examine the green "Download now" button carefully for a grayed-out "Installer Enabled" sign; if it's there, it means the application is installed using Download.com's own installer, which contains bundleware. You'll find that MD5 & SHA Checksum Utility is downloaded through Download.com, but thankfully there's no bundleware included.

Programs such as Unchecky and the Premium version of Malwarebytes screen most of these out—you still get the original program, but they either change the bundleware's default settings to prevent the extra programs being installed by default, or may block the bundleware portion of the app. Either way, you get a notification that they've worked on your behalf.

Even if you have these programs installed, they're not foolproof (particularly Unchecky). Therefore, you need to take extra care during the installation process—look out for license agreements referring to other programs, and examine any checkboxes carefully to ensure you're not


ransomware - Google Se
https://www.google.co.uk/search?site=&source=hp&q=ransomware&oq=ransomware&gs_l=
Google
ransomware
Sign in
All
News
Images
Videos
Books
More
Search tools
Learn more
Got it
WOT
click to view details
enigmasoftware.com
Trustworthiness
Child Safety
Malware or viruses
Scam
Misleading claims or unethical
Suspicious
Poor customer experience

About 8,750,000 results (0.39 seconds)

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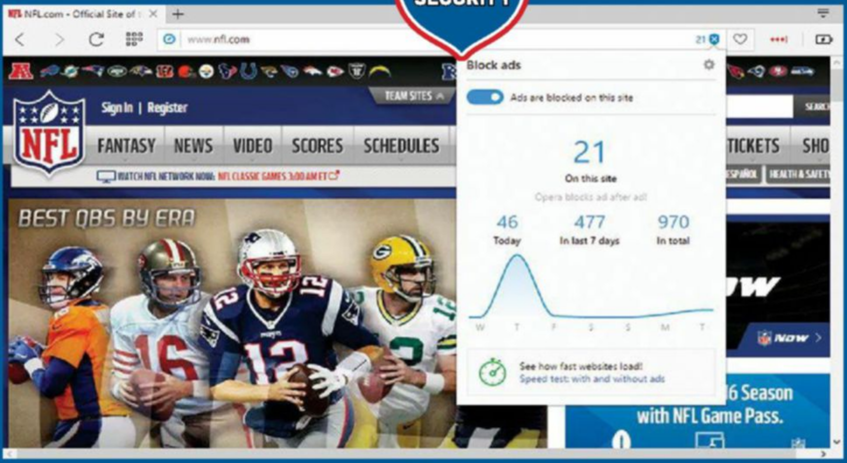
Remove Ransomware Virus - enigmasoftware.com
Ad www.enigmasoftware.com/
How to Remove Ransomware Malware. Ransomware Removal Instructions.
DNS Unlocker Removal. · Malware Removal
SpyHunter Malware Removal · Remove Spyware

ransomware
/ˈrans(ə)mwɛː/
noun
a type of malicious software designed to block access to a computer system until a sum of money is paid.

Make a habit of vetting suspicious websites with the help of WOT.

BLOCK MALVERTISING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SHO
TEAM SITES
WATCH NFL NETWORK NOW: NFL CLASSIC GAMES 3:00 AM ET
BEST QBS BY ERA
NOW
6 Season
with NFL Game Pass.
Block ads
On this site
Opera blocks ad after ad
Today
In last 7 days
In total
W
T
F
S
S
M
T

Ads are blocked on this site

21 On this site

46 Today

477 In last 7 days

970 In total

See how fast websites load!
Speed test: with and without ads

Many instances of ransomware are delivered through malicious advertising—or “malvertising.” This is the process of injecting malicious malware-laden ads into legitimate online advertising networks and webpages—since 2012, billions of ad impressions have been hijacked, including trusted sites. This malware gets through defenses, and can silently infect users’ systems—no interaction required.

So, how do you protect against these ads? Your anti-malware software should have some protection—both Norton and the Premium version of Malwarebytes have defenses against malicious websites built in, and you’ll see a steady stream of alerts as sites are blocked, not just from your browser, but other apps, such as Skype, too.

Make sure you’re running the latest version of your browser and Adobe Flash, as some malvertising targets vulnerabilities, as we discussed in the “Importance of Being Updated” box. Speaking of which, setting Flash to run only on your say-so is a good idea, as encouraging advertisers to stop using Flash for their ads is one way to improve security going forward.

There’s also an argument for avoiding dangerous websites, where these kinds of ads (as well as other unwanted pop-ups) tend to proliferate—use your WOT or Norton Safe Web browser plugin to steer clear.

Perhaps the most effective way to protect against malvertising is through ad-blockers, which block all ads that aren’t expressly allowed. Norwegian browser Opera (www.opera.com) is the first to provide ad-blocking natively—no plugins required. Alternatively, install the AdBlock Plus plugin (https://adblockplus.org), which works with all major browsers and is open-source. Be sure to whitelist trusted (and responsible) sites, though, as adverts are the lifeblood of many, enabling them to distribute content for free.

about to inadvertently install an unwanted extra. Some offers come with “Accept” and “Decline” options—choose the latter, and you move on to the next part of the process, or close the installer and source a different program that doesn’t take such risks with your security (often, authors have no control over what bundleware is installed with their program).

Fan of torrenting? You need to be doubly cautious—torrents from official sources (such as Linux installer ISOs) are usually safe, but if you’re venturing into dodgy territory, looking for the latest TV episodes, be very wary. Check comments and reviews of individual torrents to see if anyone else has spotted anything dodgy, and run the usual scans before opening any files.

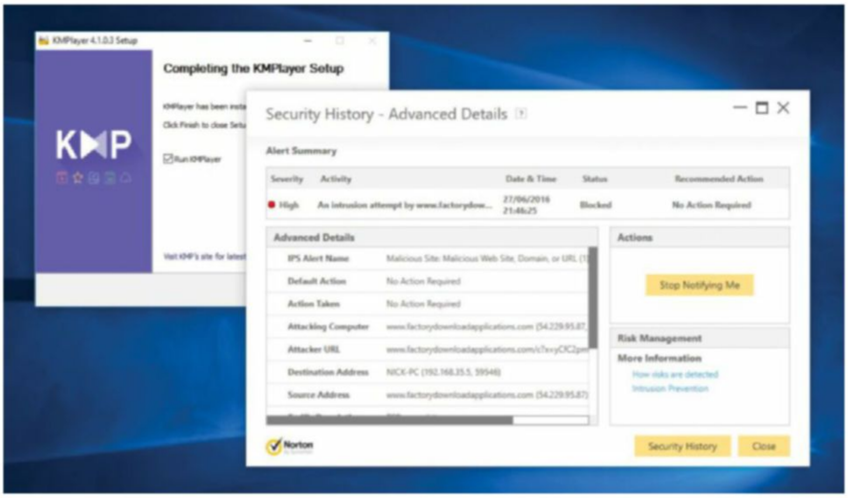
SOCIAL NETWORKING

One way in which we inadvertently hand out personal data is through our social networking profiles. Ask yourself if you really want to share your birthday publicly with everyone on Facebook, or why a particular social networking add-on needs to know so much personal information about you. Take the time to check your profile’s privacy settings on all your networks, to review what data you’ve handed over to the network, and how much of it is public. Avoid making public posts that unintentionally give out information you use as security questions elsewhere (your mother’s maiden name, for example, or the city of your birth). And, as always, ensure your accounts are protected by strong passwords, with two-factor authentication where possible.

Many web links shared over social media—particularly on Twitter—are often shortened to save on characters, but how do you know the link published is genuine? Visit http://checkshorturl.com, where you can input the shortened link to examine the original webpage it points to, plus check the link’s safety ratings on WOT, Norton, and various other reputable sites.

RANSOMWARE

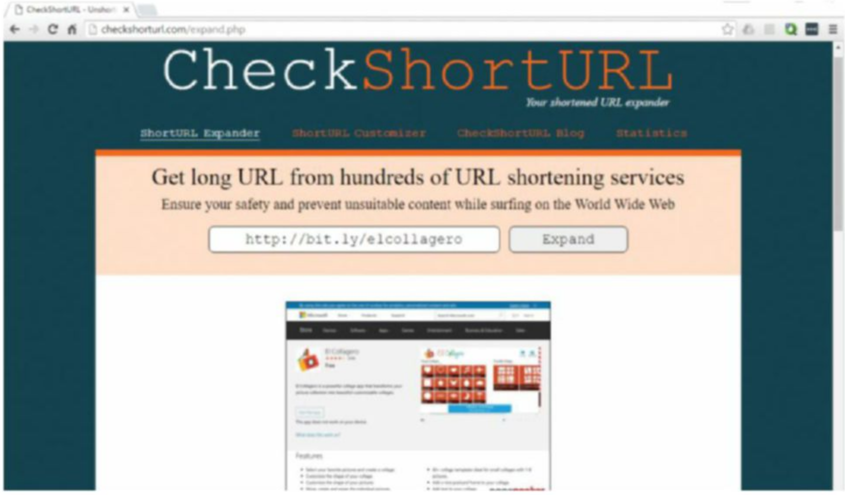
One of the biggest threats in recent times comes from ransomware, specially formed malware that locks you out of your PC or your data (typically by encrypting it), before demanding a ransom in return for receiving the code required to unlock it. One clever trick on the thieves’ part is to ramp up the pressure by hiking up the ransom cost the longer you delay. Most anti-malware tools


KMPlayer 4.1.0.3 Setup
Completing the KMPlayer Setup
KMP
☑ Run KMPlayer
Security History - Advanced Details
Alert Summary
Advanced Details
Actions
Stop Notifying Me
Risk Management
More Information
How risks are detected
Intrusion Prevention
Norton
Security History
Close

Severity	Activity	Date & Time	Status	Recommended Action
● High	An intrusion attempt by www.factorydow...	27/06/2016 21:46:25	Blocked	No Action Required

IPS Alert Name: Malicious Site: Malicious Web Site, Domain, or URL (1)
Default Action: No Action Required
Action Taken: No Action Required
Attacking Computer: www.factorydownloadapplications.com (54.229.95.87
Attacker URL: www.factorydownloadapplications.com/c7xvyCfC2p
Destination Address: NICK-PC (192.168.35.5, 59546)
Source Address: www.factorydownloadapplications.com (54.229.95.87)

Be careful installing programs that may attempt to add unwanted extras.


CheckShortURL - Unshor

checkshorturl.com/expand.php

CheckShortURL

Your shortened URL expander

Get long URL from hundreds of URL shortening services

Ensure your safety and prevent unsuitable content while surfing on the World Wide Web

http://bit.ly/elcollagero

You should always find out where short web links actually direct you.

should offer some form of protection, but check with your vendor to see what it can and can't do. BitDefender has released a "vaccine" that can block some ransomware, by tricking it into thinking the computer is already infected—see the March 28 entry under https://labs.bitdefender.com/blog/ for details and a download link.

The most effective way to protect against ransomware is to keep your PC backed up—a drive image of an entire drive, or file-based backups of your data (including cloud services, such as OneDrive) ensure you're protected. In the case of file-based backups, these offer multiple versions of your files, enabling you to roll back to a pre-hijacked version; drive images enable you to wipe the drive and restore Windows, your apps, settings, and data from scratch, with all but those changes made since the image was taken. Use a tool such as Macrium Reflect Free (www.macrium.com/reflectfree.aspx), with daily incremental images to keep the file size down.

Try to keep at least one copy off-site—in other words, not directly connected to your computer. Otherwise, it's possible that the ransomware could locate the backups and encrypt those, too. Future attacks may target your cloud storage, for example.

REPAIRING THE DAMAGE

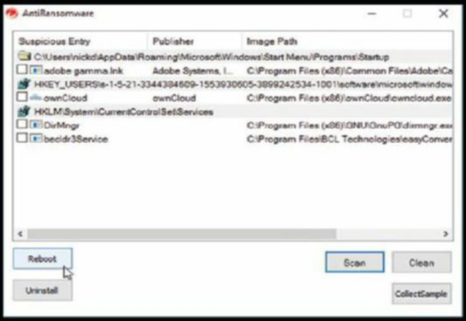
It's not always possible to keep infections off your system, so what can you do if they get through your defenses? If your system is working, try running scans with your existing tools—reboot into "Safe mode with networking" if necessary, via "Start → Settings → Update & Security → Recovery → Restart now," to access the Advanced start-up menu. From here, choose "Troubleshoot → Advanced options → Startup Settings," then restart, and pick option 5. If this fails, you need some additional tools. First, download RKill and ADWCleaner from https://toolslib.net (use another PC if necessary, transferring them across on CD or DVD). Run the former to terminate known malicious processes, but don't reboot if prompted. Next, launch Malwarebytes, update it, then select "Settings → Detection and Protection → Scan for Rootkits," before running a Threat Scan, letting it clear everything it finds.

If you need additional cleaning of adware, browser toolbars and hijackers, and other PUPs, run ADWCleaner, plus Malwarebytes Junkware Removal Tool (www.malwarebytes.com/junkwareremovaltool/), which may find things missed by Malwarebytes itself. See the box on the right for tips on removing ransomware.

Another tool to consider is the Emsisoft Emergency Kit—this is a portable dual-engine scan and remove tool, which can be downloaded direct to a portable USB drive on another PC (be warned: it's rather large, at 228MB). Run the tool once on the second PC, and update it when prompted, then plug it into your sick PC, and let it attempt to find and remove the nasties.

Once your PC is clean, you may need to perform certain repair tasks. NetAdapter Repair All In One (https://sourceforge.net/projects/netadapter/) can help with broken Internet connections, for example, while the Windows Repair Tool (www.tweaking.com) can give your system the once-over, as well as restore functionality, such as resetting Registry and file permissions, removing policies set by infections (such as blocking access to Task Manager or Regedit), and repairing Safe mode.

With your PC running smoothly, follow our tips to tighten security, then restore any backups if necessary. With a fair wind, you'll put your security scare behind you, and sail into calmer, safer waters going forward.


AntiRansomware

Suspicious Entry	Publisher	Image Path
C:\Users\nickd\AppData\Roaming\Microsoft\Windows\Start Menu\Programs\Startup		
☐ adobe gamma.lnk	Adobe Systems, I...	C:\Program Files (x86)\Common Files\Adobe\Ca
HKEY_USERS\s-1-5-21-3344384609-1553930605-3899242534-1001\software\microsoft\window		
☐ ownCloud	ownCloud	C:\Program Files (x86)\ownCloud\owncloud.exe
HKLM\System\CurrentControlSet\Services		
☐ DirMngr		C:\Program Files (x86)\GNU\GnuPG\dirmngr.exe
☐ becldr3Service		C:\Program Files\BCL Technologies\easyConver

Recovering from Ransomware

What happens if you receive a ransomware demand? First, identify its type—there are those that block access to your PC, and others that encrypt data, then demand a ransom to release it. The former usually tries to trick you by claiming to have found unlicensed software or other illegal material on your PC, while the latter is more upfront.

Make a note of the Bitcoin wallet address used for payment demands, plus the filelist of encrypted data—should the private keys used by the criminals ever come to light, it may give your data. Next, verify you have a recent backup that's safe and uncompromised (check on another PC).

Finally, you need to clean your system. Try running scans with your anti-malware tools to see if they can remove the infection. If necessary, reboot into Safe mode—hold Shift as you click the power button, and choose "Restart," which should bring up the Advanced Boot Options menu. From here, select "Troubleshoot → Advanced options → Startup Settings," and choose option 5.

If the scans don't help, try a dedicated removal tool—search for "ransomware," "removal," and anti-malware vendors, including Trend Micro and BitDefender. If you can identify the exact form of ransomware, you might find a specific removal tool.

These tools tend to focus on ransomware that blocks access to your PC. If your files are encrypted by ransomware, in most cases you have to rely on your backup to restore them (only after verifying the infection has been removed). Visit https://noransom.kaspersky.com first, though, as it has tools that can decrypt files from a wide range of data-scrambling ransomware infections.

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TECH PORN

Sennheiser HD 630VB

SOUND: IT DEFINES OUR WORLD. It's the birdsong in the early morning hours, the rumble as those eight cylinders roar into life, the hum of the waffle iron as it, er, irons waffles. Unequivocally, it's one of our most important senses. Life is not over without it, but losing it is a devastating blow to most. And that is why you should enjoy it as best you can, whenever you can. Once the din of the day's work has subsided, and the hustle and bustle ebbs away as the big city rests its weary head, the best thing you can do is sink into a good chair, slide on your favorite pair of cans, slap on some high-resolution acoustics, sit there, and just listen. Therapeutic? Most definitely.

Sennheiser's latest HD 630VBs are designed with all of that in mind, and built with passion. The combination of build materials and mechanisms come together to create this beautifully crafted pair of headphones, to provide the listener with a truly astronomical experience, far beyond that of the likes of $10 earbuds.

–**ZAK STOREY**

SENNHEISER

1 STEEL REINFORCED BAND

Comfort is key, and Sennheiser has gone all out to ensure that you're well spoilt. The aluminum headband lining the top of the HD 630VBs is strong and secure, the rubber coating gorgeous, and the memory foam headliner softer than a baby rabbit's ears.

2 BASS DIAL & INLINE CONTROLS

Multi-purpose headphones—that's what it's all about nowadays. Inline mic, four-pole jack, 6.3mm adapter, volume and playback controls: damn straight. What is particularly neat about the HD 630VBs, however, is the inline bass control. Notice that serrated ring around the earcup? You can adjust that to change the level of bass at will, regardless of whether you're on a PC or a mobile device.

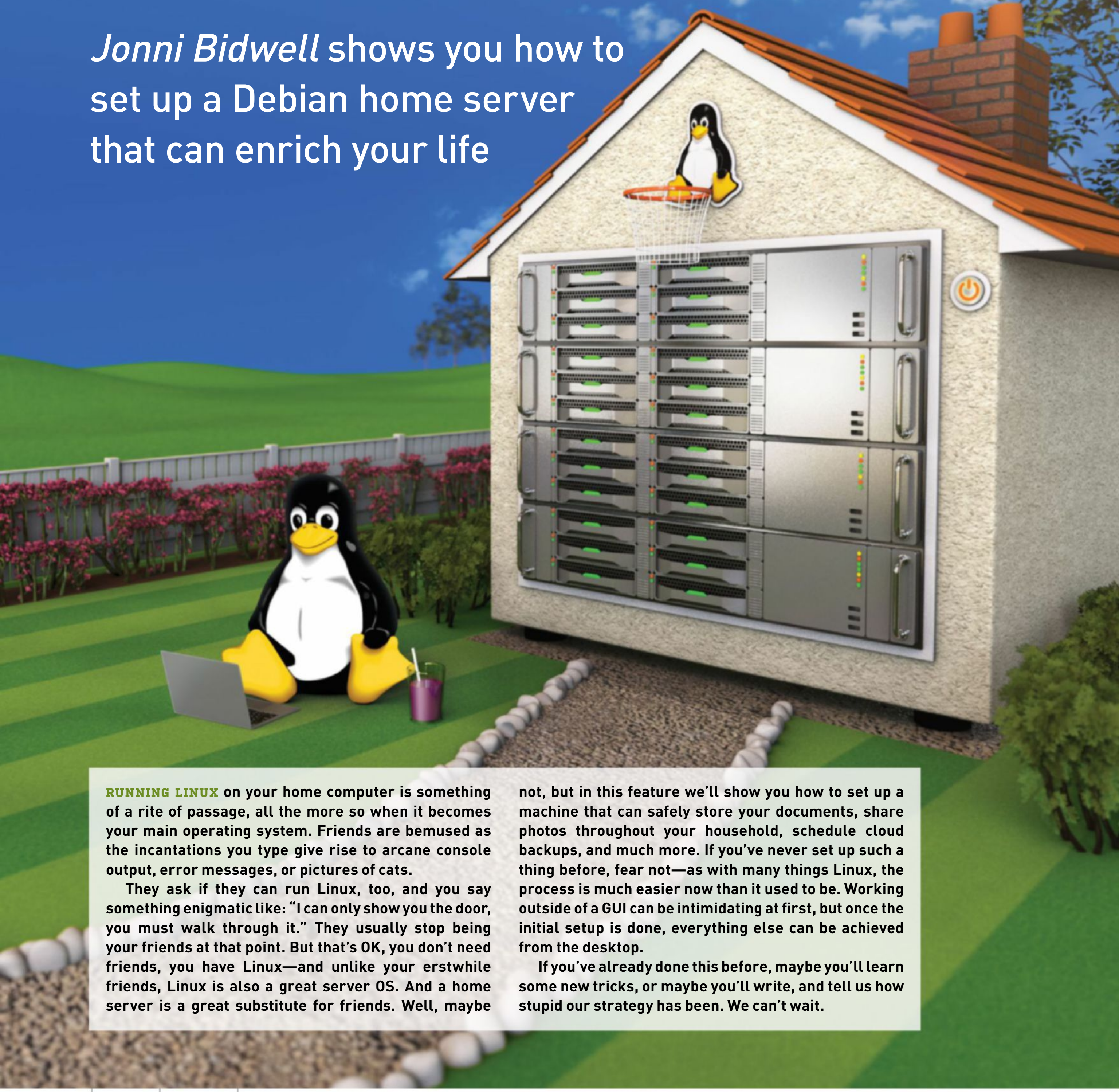
HD 630VB
VARIABLE BASS BOOST
MIN
MAX

3 DYNAMIC DRIVER

What really grabbed our attention with the Sennheiser HD 630VBs was the drivers. These circumaural, dynamic closed-back design headphone drivers have an impressive frequency response of 10–42,000Hz. That's higher than anything we've ever tested in the office—and, boy, is it good!

The Ultimate Home Server

Jonni Bidwell shows you how to set up a Debian home server that can enrich your life



RUNNING LINUX on your home computer is something of a rite of passage, all the more so when it becomes your main operating system. Friends are bemused as the incantations you type give rise to arcane console output, error messages, or pictures of cats.

They ask if they can run Linux, too, and you say something enigmatic like: "I can only show you the door, you must walk through it." They usually stop being your friends at that point. But that's OK, you don't need friends, you have Linux—and unlike your erstwhile friends, Linux is also a great server OS. And a home server is a great substitute for friends. Well, maybe not, but in this feature we'll show you how to set up a machine that can safely store your documents, share photos throughout your household, schedule cloud backups, and much more. If you've never set up such a thing before, fear not—as with many things Linux, the process is much easier now than it used to be. Working outside of a GUI can be intimidating at first, but once the initial setup is done, everything else can be achieved from the desktop.

If you've already done this before, maybe you'll learn some new tricks, or maybe you'll write, and tell us how stupid our strategy has been. We can't wait.

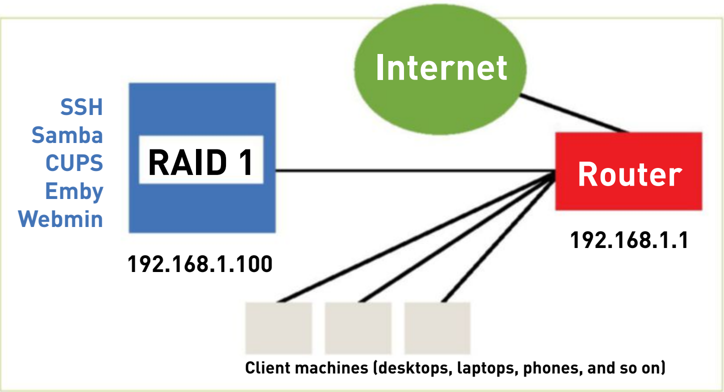
Building and Configuring

Assemble and pray to $DEITY for the happy beeps. Then install Debian

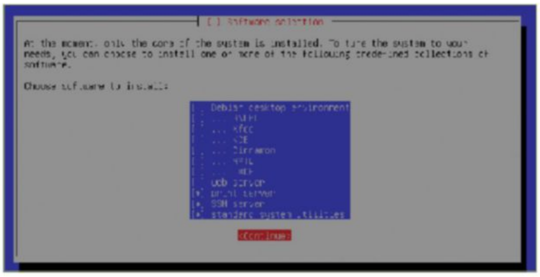
NOT THAT LONG AGO, we would have needed to spend a good page talking about hardware considerations. Back then, hardware support was something of a minefield—here, we've squished it all into a box (below).

Things still aren't perfect on Linux, but serious hardware incompatibilities tend to be reserved for laptops, so any issues you run into elsewhere are usually pretty minor and easily corrected. In theory, you could cobble any old bits together and make a server, but old components (particularly hard drives and power supplies) have a habit of breaking, and broken is generally not a good state for a server to be in. Further, when these components do break, replacements are often only available second-hand (and often at a vastly inflated price), so may not last long. Also, that 10-year-old IDE drive that's been sitting on your desk all year is unlikely to be fast or capacious enough to be useful. Add to that the fact that old gubbins is inefficient, and tends to get hot and noisy (and nobody likes inefficiency, fires, or disturbance), and our "perils of relying on old hardware" talk is done. By all means use spare parts that you have lying around, but only if you're confident they will last.

We're going to use Debian for our server, though all the packages we refer to are available on other distros, so you can use whatever you like. If you really must, this includes desktop distros, but we have no need of GUIs where we're going. So things like Ubuntu Server, CentOS, or Arch Linux are more reasonable choices. We're going to have a really simple partition set up for our OS drive—just an ext4 partition for the OS, and a swap partition—basically, what you get if you accept the defaults on a standard install. While some people would be tempted to do something more exotic, such as snapshots, rescue partitions, and LVM, we're working on the theory that if the worst does happen, our configuration will be easy to replicate with a fresh install. Backing up a couple of key configuration files will make this process even easier.



Our server, the wonderful services it will provide, and its place in the wider network.



This is the minimal Debian collection set we started with. The installation took up just over a gigabyte.

Debian is easy to install—just grab the ISO (either the small Network Install, or the first CD from the install set) from www.debian.org, and away you go. You're prompted to set a password for the root user—setting this to blank disables the root account and installs sudo, which you may prefer. You'll certainly want at least one user account at this stage; others can be added as required (with draconian storage quotas, if you want to be that kind of sysadmin). The "Guided—use entire disk" option sets up an ext4 and a swap partition, which is all our server needs.

Once everything's installed, reboot into the new system, and log in as root (or your user if you disabled the root account; we'll use the `#` prompt to indicate commands that require `sudo` usage). It's good practice to keep your server up to date, so our first act is to update package lists, and catch any last-minute upgrades:

```
# apt-get update
# apt-get upgrade
```

HARDWARE

A typical home server doesn't need much processing power—a dual-core Pentium chip is fine, and 4GB of RAM is more than enough. A wired connection is preferable to a wireless one; consider investing in powerline adapters if your server has to live far away from your router. It's worth investing in gigabit Ethernet (which might also entail a home router upgrade), particularly if you envisage lots of data flowing between your server and client machines around your home. Small cases are great for hiding in nooks and crannies, but the popular Mini-ITX cases tend not to be able to accommodate more than one or maybe two 3.5-inch drive, which may be a problem.

We're installing our OS on one drive (ideally an SSD, but it could be a hard drive, or even a fast USB stick), and have a two-drive RAID 1 (mirrored) array for storage. Our OS drive should be at least 20GB; we won't be putting much there, but room to move can be helpful. Large SSDs are expensive, so spinning disks are preferable for terabyte-scale storage. Mirroring drives might seem unnecessary (especially when we tell you that RAID is no substitute for backing up), but failures happen, and servers deserve more caution than a home machine. If you have a different disk strategy in mind, that's fine—these are just guidelines.

Adding a RAID Setup

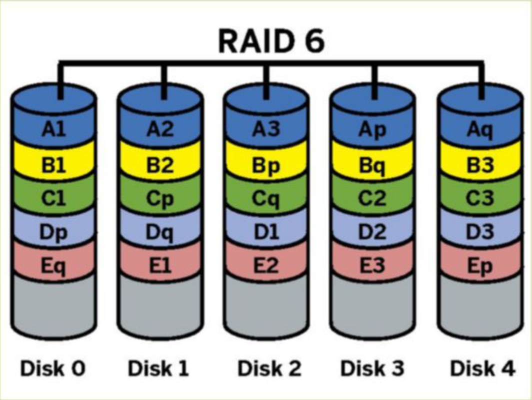
Set up a mirrored array of redundant storage, and then make your server easy to find with a static IP

THE NEXT STEP is to set up a software RAID array using mdadm. Let's suppose we have two 1TB drives, which can be had for about $50 a pop nowadays. There is a natural aversion to sacrificing capacity; it would be tempting to have two large partitions (one on each drive), but if one drive fails, you lose half your data, and by Murphy's Law, it will be the good half. You could be even more reckless, and conjoin multiple drives together (JBOD) into a single logical volume, but here, if one drive fails, you lose all your data. Don't hate your data. There's also a common misconception that your drives have to be identical for RAID. This isn't true—in fact, there's a reasonable argument for using different drives, or at least drives from different batches, in case of manufacturing faults.

With the drives connected, check their device nodes by running `lsblk`; it would be inconvenient if we wiped our Debian install. Let's assume our data drives are /dev/sdb and /dev/sdc. The first step is to partition the drives, and for this purpose, we'll use `gdisk` (strictly necessary for drives larger than 2TB). SSH into your server (as root if you set a password earlier), and run:

```
# apt-get install gdisk
# gdisk /dev/sdb
```

Enter `p` to list any extant partitions. You'll want to delete these by pressing `d` and following commands until there's none left. Now create a new partition by pressing `n`, and accept the default of 1 for its number. Also accept the default start sector by pressing Enter. We could just use all of the drive, using the last sector to mark the end of the partition, but this is potentially risky: There are often discrepancies of a few megabytes between drives of ostensibly the same capacity (even ones with identical model numbers). This won't be a problem right away, since mdadm uses the size of the smallest drive, but we may have to replace one in the future, and it would be annoying if this replacement drive came up just a little short. So, in this case, we might enter `-1G` for the last sector, sacrificing 1GB. This is probably overly cautious, but it's only about 0.1 percent of the total capacity, and could save much hassle later. Use a similar ratio if your drives are differently sized, and use trial and error if your math is shaky—do-overs are allowed if you mess up. Enter `FD00` when prompted for the partition type, and then press `p` to make sure things look OK. If they do, press `w` to write the table to the disk. Now quit gdisk and repeat the process for /dev/sdc.



Wikipedia will tell you all about the more exotic RAID levels, but you need more than two hard drives for them to be of any use.

We also need to install and configure mdadm. Installation is simply `# apt-get install mdadm`, which asks whether you need any mdadm devices to be available at boot time. We don't, so just enter `none`. As a final step, we wipe the drives' superblocks, in case data from any previous RAID arrays is still there:

```
# mdadm --zero-superblock /dev/sdb /dev/sdc
```

With the drives now primed, we can create our mirrored array:

```
# mdadm --create /dev/md0 --level=1 --raid-devices=2
/dev/sdb1 /dev/sdc1
```

This asks you about metadata at the beginning of the drive—don't worry, it's safe to enter `y` here. Then it creates a new device node, and at this stage, it would be rude not to put a filesystem on it: `# mkfs.ext4 /dev/md0`.

We need to create a mountpoint for our RAID device, which is just a matter of `# mkdir /mnt/mpcraid`. Finally, we need to ensure our array is automounted at boot. We could probably get away with referencing the array by its device node (/dev/md0), but it's more failsafe to use its UUID, which we ascertain with `# blkid`. Armed with this knowledge, add a line of this form to /etc/fstab, and all should be sweet:

```
UUID="90abcdef-..." /mnt/mpcraid ext4 defaults 0 0
```

WHAT RAID DOES AND DOES NOT PROTECT

With RAID 1, if something goes wrong on our data volume, then we can restore (in the event of a single drive failure), or cry into our soup because we didn't have a backup strategy for two failures in place, and now the whole array is unreadable. That might sound alarmist, but it's important to recognize that these things do happen. Drives can also fail subtly, leading to silent data corruption, and RAID doesn't protect against this kind of thing. Hearing that news, you might be tempted to set up LVM, to conjoin your drives into a single logical volume. This has the disadvantage that if one drive breaks, the whole volume becomes unreadable. Such practice is called hating your data. Don't hate your data. Have a backup strategy in place. Much of the data you may plan on storing is likely to be pretty fungible anyway: Linux ISOs and Steam libraries can be redownloaded, DVDs and CDs you've ripped can simply be ripped again, and so forth.

Establishing a Static IP

Stop your server being—to adopt the haughty parlance of the authorities—of no fixed abode

BY DEFAULT, Debian requests an IP address from your router using DHCP. This means, though, that on the next reboot, it may well end up with a different IP, which will make SSHing in from elsewhere on the network a challenge, and also flummox any port forwarding arrangements later.

Some broadband routers enable you to reserve an IP for a machine based on its MAC address, which is one way of solving this problem, but we can also just set up a static IP on our server. We need an address that is of the same shape (by that, we mean belonging to the same /24 subnet) as that of your router—the IP address it has already assigned you is a perfectly good choice. You can find this out by running this command: `# ip a`. This shows you all kinds of useful information about your network interfaces, of which there are probably at least two: the loopback interface `lo`, and your Ethernet card `eth0`. Look for a line such as:

```
inet 192.168.1.100/24 brd 192.168.1.255 scope global
eth0
```

in the `eth0` stanza. The `192.168.1.100` part is your machine's IPv4 address (we're not going to concern ourselves with IPv6 addresses today) on your home network. Yours will be different (it might not even begin with 192.168), so don't just copy this blindly. In this case, the router's address will also commence 192.168.1. You can find the last part *(you mean octet—Ed)* either by already knowing it, by looking in the router's small print, or by running the command:

```
# netstat -nr
```

and glancing at the `Gateway` column (it's usually 1 or 254). As well as assigning IPs, DHCP also provides routing and DNS information, so since we're eschewing DHCP, we need to explicitly tell our machine about our network. In Debian, this is all done in a file, which the following commands back up and open:

```
# cp /etc/network/interfaces{,.bak}
# nano  /etc/network/interfaces
```

Replace the line

```
iface eth0 inet dhcp
```

with the following block (leaving intact any preceding lines, such as `allow-hotplug eth0`):

```
iface eth0 inet static
   address 192.168.1.100
   netmask 255.255.255.0
   gateway 192.168.1.254
```

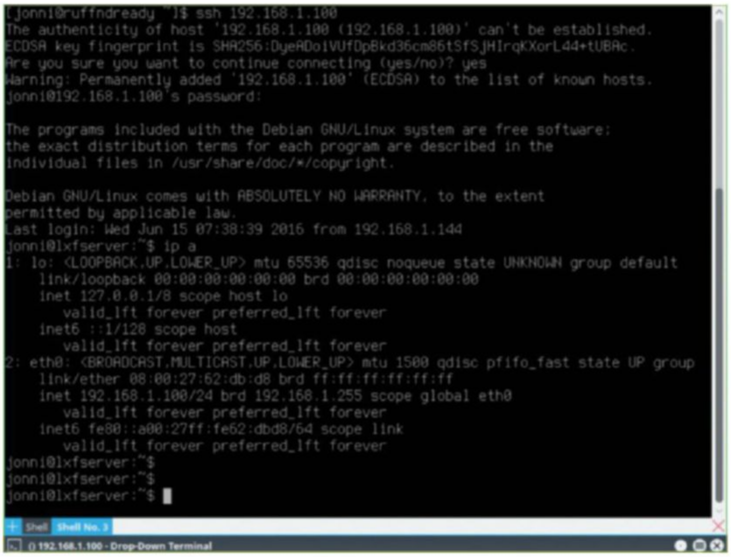
where the gateway address is that of your router. Save this file, and exit with Ctrl-x, y, Enter. We also need to tell Debian to use the router for hostname lookups, which involves another file:

```
# nano /etc/resolv.conf
```

This time, delete any lines beginning with `nameserver`, and leave in their place the line:

```
nameserver 192.168.1.254
```

Again, the IP here is that of your router (which will forward DNS queries to your ISP). You may also prefer to use Google's DNS servers (8.8.4.4 and 8.8.8.8; multiple `nameserver` lines are allowed). Either way, save, exit, then go ahead and restart the network with:



```
[jonni@ruffndready ~]$ ssh 192.168.1.100
The authenticity of host '192.168.1.100 (192.168.1.100)' can't be established.
ECDSA key fingerprint is SHA256:DyeADoiVUfDpBkd36cm86tSfSJHIrqKXorL44+tUBAc.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.1.100' (ECDSA) to the list of known hosts.
jonni@192.168.1.100's password:

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 15 07:38:39 2016 from 192.168.1.144
jonni@lxfserver:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
    link/ether 08:00:27:62:db:d8 brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.100/24 brd 192.168.1.255 scope global eth0
       valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe62:dbd8/64 scope link
       valid_lft forever preferred_lft forever
jonni@lxfserver:~$
jonni@lxfserver:~$
jonni@lxfserver:~$
```

The first time you SSH into a machine, you need to confirm the machine's fingerprint. The "ip" command displays a lot of information for few keystrokes.

```
# systemctl restart networking
```

Now check you still have connectivity with:

```
# ping -c5 google.com
```

If you see the following

```
ping: unknown host google.com
```

then something isn't right with your nameserver settings. If you see a different error message, then your `interfaces` file needs some tweaking. Try reverting the settings—aren't backups great for this kind of thing? Your router might need a different netmask.

The first thing we want to set up is SSH, so that we can log in to our server remotely. Install it with `apt-get install openssh-server`, which also starts the server. You can try logging in by running `ssh 192.168.1.100` on a different Linux machine, or using PuTTY in Windows. It's a good idea to reboot your server at this point, to check that the network settings survive a reboot, and our SSH server starts. With SSH now working, your keyboard, mouse, and monitor may be summarily dismissed (which might improve local feng shui), and we can continue setting things up from the comfort of another machine (if you want).

> With SSH now working, your keyboard, mouse, and monitor may be summarily dismissed (which might improve local feng shui).

Getting Remote Access

Control your server by dynamic DNS and forwarding ports

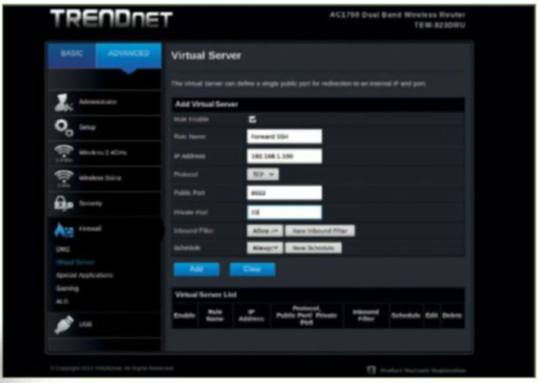
BEING ABLE TO ACCESS your server from anywhere in the world can be very handy, but running Internet-facing services carries risks. If we allow outside access to the SSH service, then we really should have strong passwords, or (better) use keys.

It's reasonable to disable access to the root account (if you set a password for it during the install; otherwise, it's already disabled), and logging in as a lowly user, using `sudo` for privileged operations. This is controlled with the `PermitRootLogin` setting in /etc/ssh/sshd_config, which you can set to `No`, or, if you want to allow root to log in using a key, `prohibit-password` (the default on Debian). It's probably a good idea to check that SSH is working first, though, so try to log in from another machine:

```
$ ssh user@192.168.1.100
```

where `user` is your username on the server (we'll use this username/IP address combination throughout). If that works, log out, and we'll generate our key (it doesn't have to be done on the server). If it doesn't work, check the logs on the server for errors with `journalctl _COMM=sshd`. To generate a 2,048-bit RSA key pair, run the command `ssh-keygen` while logged in to another machine as your user—we'll copy it to the server after. Accept the default location, and choose a password for your key. This adds an extra layer of security in the event the key is stolen.

SSH key logins work by having a public key (it doesn't matter if anyone sees it) on the server, and a private key that is safely guarded by the user. Both keys are used during the login process to authenticate the user by some mathematical sorcery. This means that forcing key-based login entails carrying your private key around with you wherever you go. Different people will tell you different things about what is the best way to do this. Basically, if you choose to keep it on a USB stick, make sure you don't go leaving that stick on the train/bus/horse-drawn carriage.



This is what port forwarding looks like on a budget Trendnet router. It will be different on other hardware, but the basic idea is the same.

Running `ssh-copy-id user@192.168.1.100` adds our public key from the default location (~/.ssh/id_rsa.pub) to the file /home/user/.ssh/authorized_keys on the server. This can be done manually, too, but why waste keystrokes? We can test it works like so:

```
$ ssh user@192.168.1.100
```

All going well, we should not be asked for a password. If you want to disable password logins entirely, you can add the directive

```
PasswordAuthentication no
```

to /etc/ssh/sshd_config. But doing so means that if you don't have access to your private key (in the file ~/.ssh/id_rsa), there is no access for you. If you do copy your private key, ensure that it is only readable by your user (i.e. it has file permissions 600), otherwise SSH shouts at you for being insecure. Since filesystems commonly used on USB sticks (FAT32 and NTFS) don't support Linux permissions, you need to copy the key off such media (and then run `chmod 600 id_rsa`) before attempting to log in. The private key can be copied to the .ssh directory on the machine you're working on, in which case it is picked up automatically, but it can also be renamed, or stored elsewhere—in which case, you need to use `ssh -i /path/to/key`.

There's one final step to make remote access work, and that's to tell your router to forward SSH traffic from the WAN to your home router. Our server listens on the default port (22), but we can have it listen on a different port, which at least prevents our server being found by robotic port scans. How to configure this varies from router to router, but the goal is to forward external traffic from an obscure TCP port (8022, for example) to our TCP port 22 on our server, 192.168.1.100.

DYNAMIC DNS AND SSH TRICKERY

Having remote access to our server this way is only useful if we know our router's external IP address, and most users obtain said address dynamically from their ISP, so it changes often. The solution is to use a dynamic DNS service provider (www.duckdns.org is free) to provide a hostname, and update its DNS records on request from your server. Depending on the provider, we can automate this by running a cron job once a day on our server. As well as using SSH to remotely administer our server, we can use it to send and receive files via SFTP. Most file managers allow you to navigate to sftp://mpcraid.duckdns.org:8022, for example, and log in with your user's credentials, but it's not a very efficient way to transfer large files. It would be better to set up a web-based system, using OwnCloud (https://owncloud.org), for example. Rather than exposing multiple services via port forwarding, consider tunneling them over SSH. For instance, if you have a web server on your LAN, access it with:

```
$ ssh user@mpcraid.duckdns.org -p
8022 -L8080:localhost:80
```

Now open a browser and point it at http://localhost:8080—traffic has been forwarded through the tunnel. Pro tip: You can add tunnels to an existing SSH session by pressing Enter, `~`, `c`, and entering `L8080: ...` etc. at the prompt.

Adding Samba

Get ready to dance to the sharing protocol with extra bossa nova

ONE OF THE MOST noble duties any home server can perform is sharing files. Whether it's to store the gigabytes of bangin' psytrance tunes you've amassed, or just a place to put things when you can't find a USB stick to throw at your cohabiters, having some central and communal storage space is incredibly useful. Unix-like OSes have their own file sharing protocol called NFS, which has been around since the 80s.

This is certainly an option, but not one we'll indulge today. Instead, we'll use Samba, which is an implementation of the sharing protocols used in Windows. This has the advantage that our server will be accessible to any Windows machine or Mac, as well as any iOS or Android devices.

Before we set up Samba, it's a good idea to set up some directories for the network shares first. We'll store them on our RAID, which should be auto-mounted if you've rebooted since setting it up. If not, mount it now with `# mount /mnt/mpcraid`. Let's make those directories:

```
# mkdir /mnt/mpcraid/{music,public,docs}
```

We're going to allow anyone read access to all of these, and we'll also enable anyone to write to the public directory. If you have some music or documents that you feel other network users would benefit from, then now is a good time to populate those directories. Samba shares can be set up with user and password access, but for a home network, it's simpler to allow guest access to your shares. This means we'll have to make the public directory world writeable with `# chmod 777 /mnt/mpcraid/public`.

Now we'll `# apt-get install samba` and set up our shares. Edit the /etc/samba/smb.conf file, and add the following lines in the Share Definitions section:

```
[public]
  path = /mnt/mpcraid/public
  read only = No
  browsable = Yes
  guest ok = Yes
```

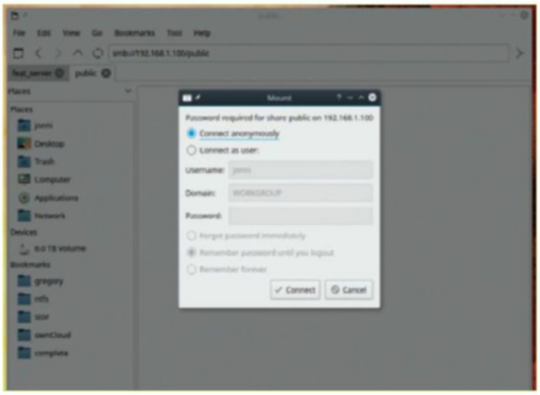
Now restart the service with `# systemctl restart smbd`. You should be able to browse the server by navigating to smb://192.168.1.100 from any file manager (this syntax also works on Mac; for Windows, use \\192.168.1.100). From Linux machines, you can mount the share via the command line (so long as the cifs-utils package is installed):

```
# mount -t cifs //192.168.1.100/public /mnt/smbpublic/
-o user=guest
```

Make entries in /etc/samba/smb.conf for the music and docs shares, as we did with public. This time, omit the `guest ok` line, and set `read only` to `Yes` (although it doesn't really matter, since those directories, for want of better phrasing, aren't writable by `nobody`).

Any files deposited will be owned by the `nobody` user, which is where Debian maps Samba's guest user to. Windows 10 is morally opposed to accessing guest shares; the procedure to persuade it to be otherwise is explained at https://techjourney.net/cannot-connect-to-cifs-smb-samba-network-shares-shared-folders-in-windows-10. User-level security (of which Windows 10 approves) is reasonably easy to set up, too, which enables private network shares to be set up. The Samba credentials can be synchronized with user accounts on the server, so this way you can (as described in smb.conf) privately share your home directory over the network.

If you run into problems configuring Samba (and you wouldn't be the first), the `testparm` program can often provide a useful diagnosis. SMB failure messages are not known for their usefulness.



Password required for share public on 192.168.1.100

● Connect anonymously

○ Connect as user:

Username:

Domain: WORKGROUP

Password:

○ Forget password immediately

● Remember password until you logout

○ Remember forever

PCManFM prompts you for either guest or user access to network shares.

PRINTING

The SMB protocol (and the newer, printer-specific IPP protocol) allows us to share printers. Once the printer and the server are friends, anyone on the network can use the printer without having to fight with "printer not found" errors. But first, you have to get computer and device to parley, using the Common Unix Print System (CUPS), which we requested at installation. Some printer manufacturers offer Linux drivers, but in general, these are built for obscure or outdated distros, and their use leads only to tears. Instead, have a look at the hardware that's supported by the free drivers at http://openprinting.org/printers—chances are your printing press is there. Many of the free drivers are installed alongside CUPS, so you might not even have to do anything here. Point a browser at http://192.168.1.100:631, then log in as root to access the CUPS web interface. Go to the Administration tab and select "Add Printer." Once auto-detected, you can click "Continue." On the next screen, there's a handy checkbox for sharing the printer. On the next and final screen, you can choose the precise driver to use, or upload your own PPD file. Your printer is now available to Windows and Linux machines using the IPP address http://192.168.1.100:631/printers/<printer_name>.

Emby and Webmin

Stream media and administer your server from your web browser

A MEDIA PLAYER, such as VLC or mpv, will happily open a file on your server remotely. But try skipping back and forth, and you'll discover that SMB is not a particularly good way to stream media. Especially if you envisage streaming to multiple users. Emby, on the other hand, is a media server that can serve content from your server or DLNA (the most horrible acronym ever created: Digital Living Network Alliance) devices.

Emby delivers streams via HTML5, and it can dynamically compress them according to the current network conditions. Note, however, that this can use a lot of CPU power, so serving a few users simultaneously might result in jittery (or outright stalled) playback. Emby can use GPU acceleration for this purpose, though, provided the appropriate drivers are installed—it currently supports Nvidia NVENC (on high-end desktop graphics cards) and Intel QuickSync (found on most recent CPUs) as an experimental feature. Besides web browsers, your content can also be streamed via apps available for Chromecast, Roku, iOS, and Android. To install Emby, we need to add the appropriate key and repository to APT:

```
$ wget -qO - http://download.opensuse.org/
repositories/home:emby/Debian_8.0/Release.key |
sudo apt-key add -
$ sudo sh -c "echo 'deb http://download.opensuse.org/
repositories/home:/emby/Debian_8.0/ /' >> /etc/apt/
sources.list.d/emby-server.list"
```

Then we can update our package lists and install:

```
$ sudo apt-get update
$ sudo apt-get install emby-server
```

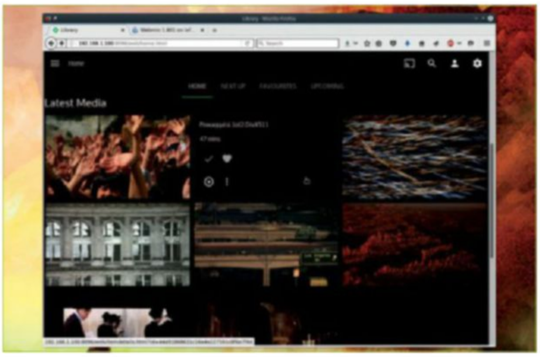
Emby is built with Mono, and has many dependencies, but APT should take it all within its stride. Once it's done, start the service with:

```
$ sudo systemctl start emby-server
```

And, if you want it to start on every boot:

```
$ sudo systemctl enable emby-server
```

Navigating to http://192.168.1.100:8096 ought to bring up the setup wizard, which will guide you through basic configuration. You'll want to add your music directory from the Samba section, and ideally have any videos you want to serve filed in a reasonably systematic manner, although Emby is pretty good at sorting things out for you. If you have a USB or PCI TV tuner installed, then Emby can use that to stream live TV to your devices, as well as record it for later viewing. You can optionally set up an Emby Connect account, which makes it easy to access your Emby instance remotely, although this can also be done the traditional way, with the port forwarding and so forth.



Emby lets us watch the classic *'Qatsi* documentaries—moving portrayals of the exigencies of a globalized society, featuring a soundtrack by Philip Glass.

CONTROL IT WITH WEBMIN

Besides frittering away hours watching media from the browser, we can also enact some serious system administration. Webmin is a web interface written in Perl that can administer all possible facets of your server. Opinions differ here, and all of this is possible through SSH, of course, but some people prefer not to have to remember the syntax of a hundred disparate config files. With Webmin, these things are all controllable through a single, graphical point of contact.

As with Emby, we add keys and repos to ensure the software stays up to date:

```
$ wget -qO - http://www.webmin.com/
jcameron-key.asc | sudo apt-key add -
$ sudo sh -c "echo 'deb http://download
.webmin.com/download/repository
sarge contrib'>> /etc/apt/sources.list.d
/webmin-server.list"
```

Then it's just a case of:

```
$ sudo apt-get install webmin
 sudo systemctl start webmin
```

The default configuration starts a web server in SSL mode, which means that when you go and visit the URL https://192.168.1.100:10000, you see a scary-looking SSL error, because it's impossible to get a valid certificate for private IP space. It's safe to add an exception here—we're only accessing it through our LAN, and it's advisable to keep it that way. With that out of the way, we can log in as our user, and be able to carry out all manner of useful tasks. For example, we can configure our Samba shares (from the Servers menu), view log files, update packages, view resource usage, pretty much anything you can imagine.

Having this much power (Webmin has root) in one place is a terrifying security prospect if that one place is facing the Internet. As such, we really don't recommend forwarding external traffic to Webmin without taking additional precautions. It's entirely possible to tunnel traffic via SSH, though, as mentioned in the dynamic DNS section earlier. Webmin enables you to use two-factor authentication via a number of providers, so that remote access can be done a little more prudently.

The Linux Raid section is particularly relevant for this guide: We can examine the health of our array, or take it offline for maintenance. If you set up Webmin soon after you created your array, you'll be able to see that it's still resynching—the process takes ages, even though it's effectively just synching a whole bunch of zeroes at this point. This information is also available in the /proc/mdstat file.

Expand and Extend

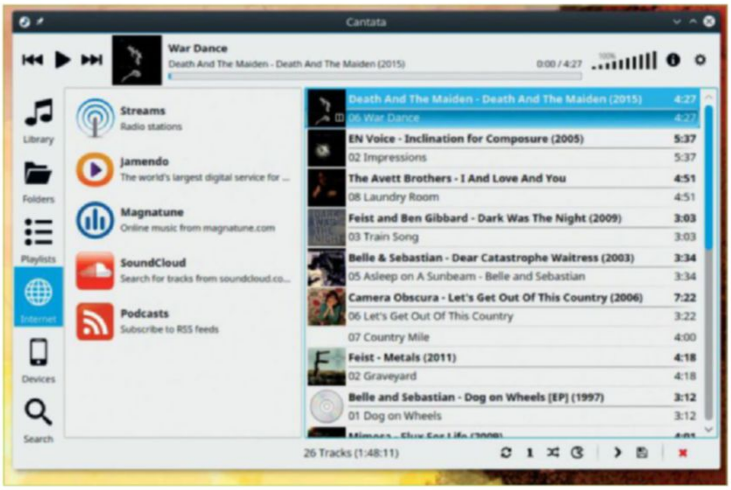
With the foundations now laid, our server project can be tailored to just about any purpose you require

WE'VE DONE MOST of the groundwork required for any server, but we haven't really considered security, and it's worth saying a few words about this. Having only SSH visible to the outside world is a good start, especially if only key-based access is possible. If the key is stolen, though, or the password is guessed (if you were lazy and allowed password access), your whole machine is vulnerable, because that user has sudo rights. Some people only allow non-sudo users to log in, but this then precludes being able to do grown-up tasks. Trade-offs between security and convenience are commonplace. Having our services only visible to the LAN relies on the fact that our network hasn't been compromised. Certainly, as long as our home network is IPv4-based, our server is shielded from direct outside access. But what if our router or another machine on our network is infected, punching a hole through that convenience?

Putting behind us the gloomy and thorny issue of security, let's consider what to do next. Ultimately, you're only limited by your imagination. For a start, if you have a spare pair of speakers (or if your server's in the living room, hook it up to your amp), look into setting up mpd. It's a lightweight Music Player Daemon that can be controlled via a web interface, client programs, or apps on mobile devices. Some client programs enable you to connect your listening with social services, such as Spotify and Last.fm; some (such as the glorious ncmpcpp) can be run entirely from the command line. If you really want, you could then connect your server to your television, but to make the most of this arrangement would require installing a GUI on the server. And that wasn't a road that we wanted to venture down for this guide.

When connecting to the Internet from public Wi-Fi, it's wise to use a VPN to protect your traffic. There are commercial offerings here, but why not set up your own OpenVPN server? Again, tunneling it via SSH might be the best option, or at least changing the default port. It's easy enough to set up, but you need to understand a little bit about how certificates, TLS, and things work. Armed with that knowledge, you can secure all traffic between the questionable hotspot and your server, and if you trust your ISP (or at least are browsing via HTTPS), you have a lot less to worry about. In the interests of energy conservation, it's a good idea to put your server to sleep overnight if no one's going to need it. This requires recent hardware, but no additional software—the machine commences Zs as soon as you tell it `$ sudo systemctl suspend`. Apropos to this, one can also configure Wake on Lan (WoL) so it can be woken up again from anywhere on the network. The ethtool program needs to be installed on the server, and the wol package on any machine from which you want to rouse it.

Finally, we should discuss some options to minimize the damage in case your server is struck by lightning or overzealous use of the `rm` command. It would probably take less than half an hour to reinstall the system—it would be quicker if we had copies of the relevant configuration files to hand. Small files like this are ideal for backing up to the cloud (so long as they don't contain passwords or other sensitive material).



Death And The Maiden - Death And The Maiden (2015)	**4:27**
06 War Dance	4:27
EN Voice - Inclination for Composure (2005)	**5:37**
02 Impressions	5:37
The Avett Brothers - I And Love And You	**4:51**
08 Laundry Room	4:51
Feist and Ben Gibbard - Dark Was The Night (2009)	**3:03**
03 Train Song	3:03
Belle & Sebastian - Dear Catastrophe Waitress (2003)	**3:34**
05 Asleep on A Sunbeam - Belle and Sebastian	3:34
Camera Obscura - Let's Get Out Of This Country (2006)	**7:22**
06 Let's Get Out Of This Country	3:22
07 Country Mile	4:00
Feist - Metals (2011)	**4:18**
02 Graveyard	4:18
Belle and Sebastian - Dog on Wheels [EP] (1997)	**3:12**
01 Dog on Wheels	3:12

Cantata is a Qt5-based client for MPD. It can deal with cover art, as well as all manner of online services.

WE NEED TO TALK ABOUT BACKUP

This can be automated for services such as Dropbox, but it also isn't too much of a chore to periodically do this manually. In this guide, we could back up our Samba, fstab, and APT sources lists. One method by which the backup could be done is by rsync-ing to another server via a maintained list of files to back up. Rsync is a hardcore protocol that can do deduplication, so it's good for transferring large files efficiently, provided you have somewhere suitable to transfer them to.

Sending large files to the cloud rapidly becomes time-consuming and logistically problematic. There is free storage available, but whether you can find enough of it, and whether it can be accessed without some nasty proprietary app, is a different story. If you have a fast network connection and unlimited funds, a remote rsync machine is the best option. Good practice dictates that off-site backups are good, but cloud storage is expensive, and people aren't very good at deleting things no longer required. The next best thing would be to back up the important files on your RAID to an external hard drive (or perhaps a NAS), and store this off-site. ⏻

> “We should discuss options to minimize the damage in case your server is struck by lightning or overzealous use of the “rm” command.

72
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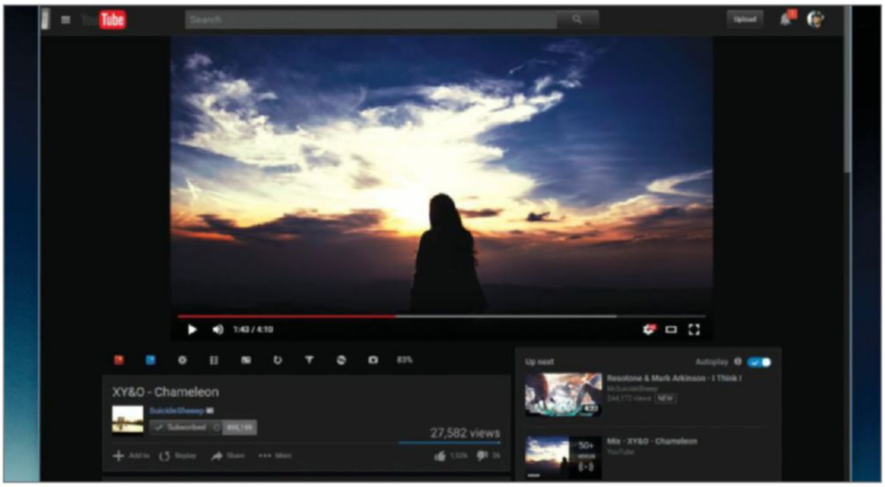
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



DIM YOUTUBE'S BORDER

Are you a regular YouTube viewer? Do you find its piercing white background too bright? Especially at night? There's a simple fix: Magic Actions is a nifty Chrome extension that adds a light switch to the top-left corner, enabling you to swap between the standard template and a gray alternative. It also comes with auto-wide features, auto-HD to your specifications, and other options that will make your video-watching life even better.

MAKE – USE – CREATE

62
Make your own
RPi MusicBox
AirPlay receiver

68
Design yourself
some "hope" with
Affinity Designer

70
Build your own
microATX 4K
gaming box

ZAK STOREY
STAFF WRITER

OEM M.2 SSDs

PCIe NVMe SSDs are undoubtedly the drives to have right now. Take a quick look at any of those small form factor Samsung SSDs, and you'll soon realize why they're so desirable: 512GB of storage, read speeds up to 2,150MB/s, and writes at 1,500MB/s. They're faster than a triple-SSD RAID 0 setup, and more reliable, too.

So, what's the problem? Well, it comes down to OEM drives. You may have noticed the launch of Samsung's latest SM961 M.2 solid-state drive. With capacities up to 1TB, and read speeds topping out at 3,200MB/s, it sounds damn near incredible. A dream come true, surely? Well, yes and no—although these drives are available to buy from many etailers, according to Samsung they aren't meant for the general public, but for system integrators and those looking at the business side of super-fast storage.

Apparently, we—consumers—lose out on a suitable warranty, customer support, and software support (which, let's face it, seeing as these are mostly OS drives on our part, won't make a difference anyway). More importantly, of course, there's no way we can get a drive in our office to test one ahead of time for you. Yep, no review samples for us here at *Maximum PC*. Considering that these are going to be some of the most desirable drives available until the commercial launch of the new 950 equivalents in September this year (rumored), that's not a viable excuse in our eyes. Sorry Samsung, we're not impressed.

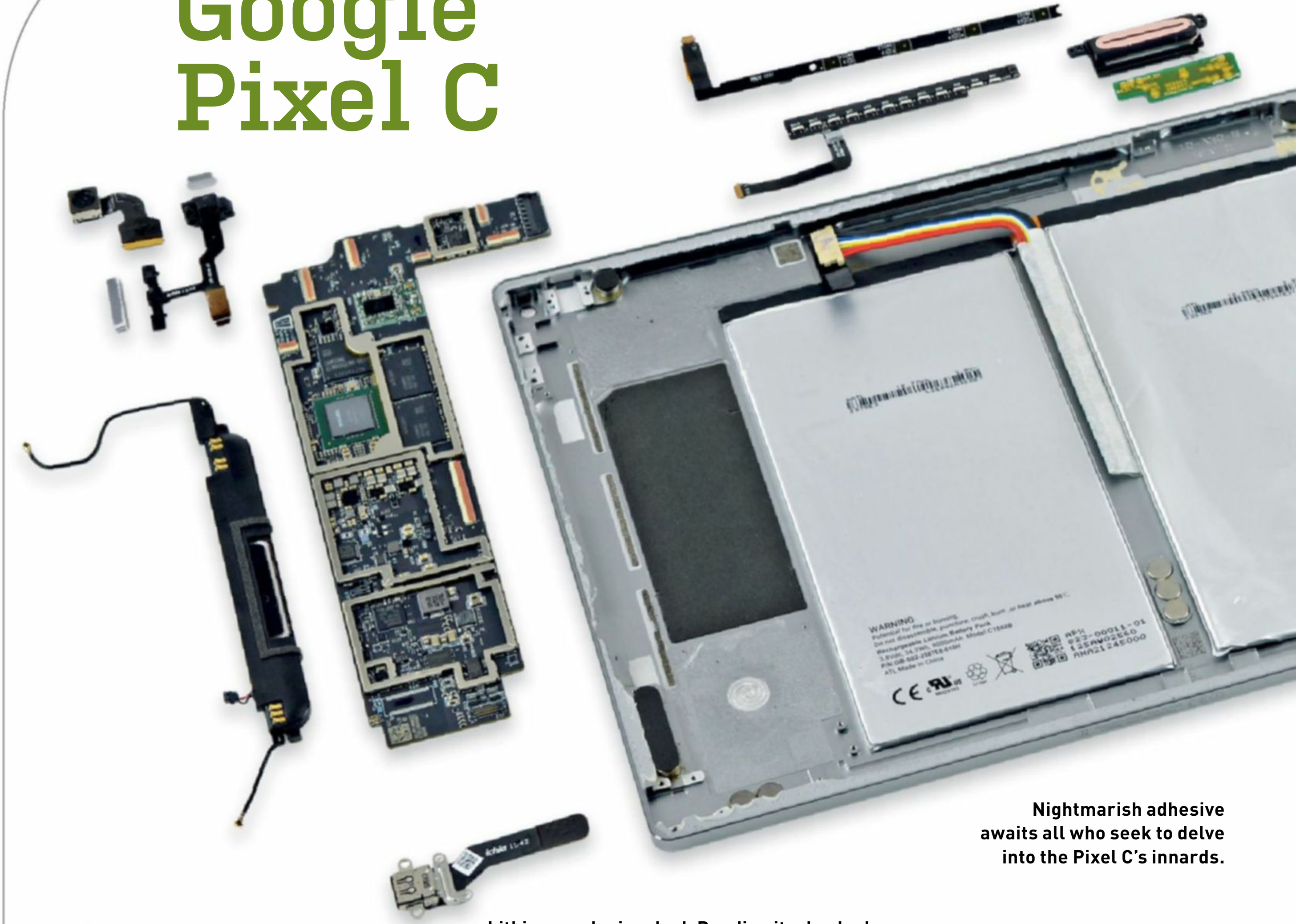
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Google Pixel C



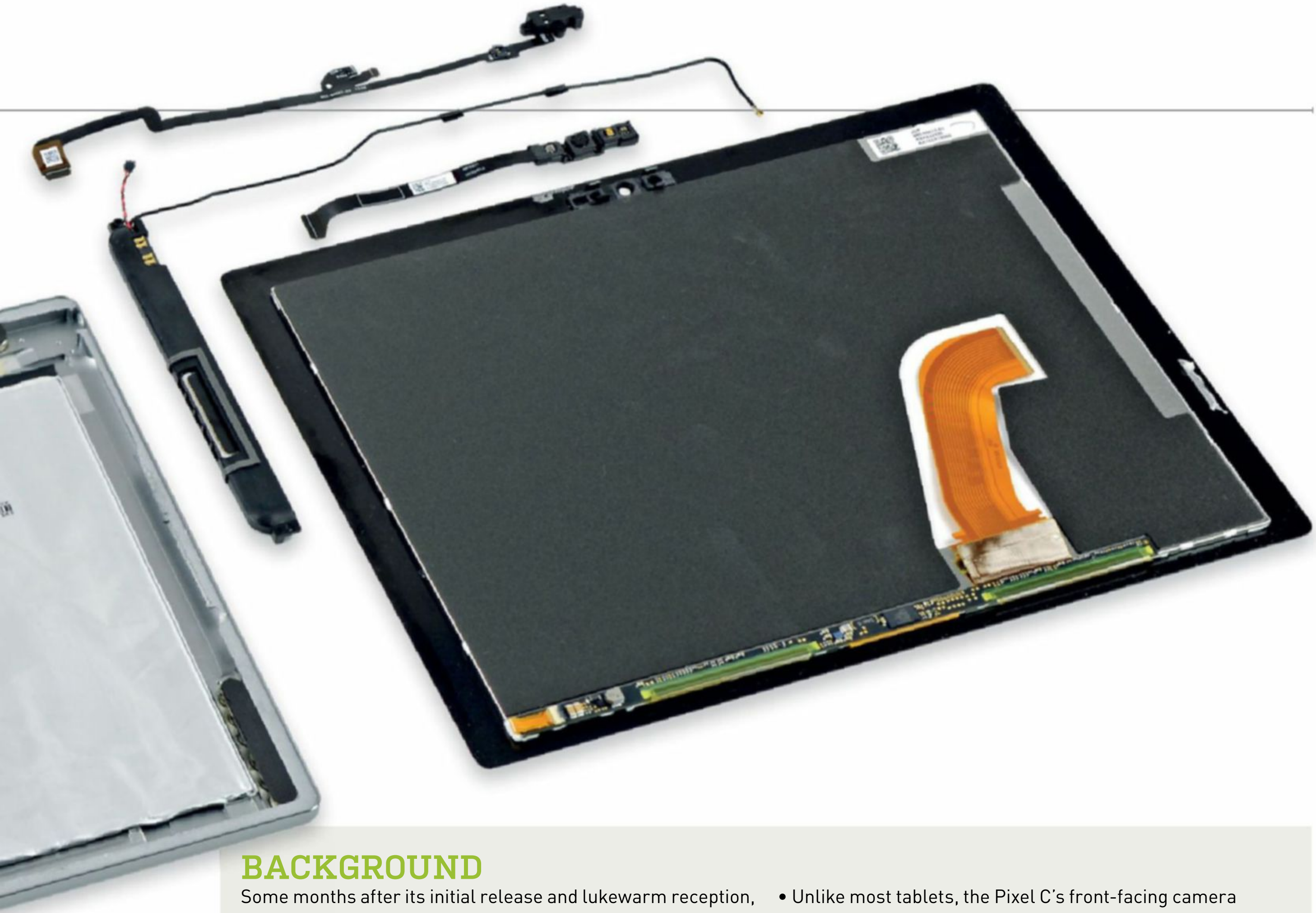
Nightmarish adhesive awaits all who seek to delve into the Pixel C's innards.

Lithium explosion: bad. Bending it: also bad.

It's worth noting that the keyboard isn't included as standard, but it's an essential component in our eyes.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



BACKGROUND

Some months after its initial release and lukewarm reception, the Pixel C has found its way back into the news, with a hefty discount to developers who want to try out the new Android N operating system. Sounds like it's teardown time!

MAJOR TECH SPECS

- 10.2-inch LTPS LCD with a resolution of 2560x1800 (308ppi)
- Nvidia Tegra X1 64-bit quad-core processor paired with a 256-core Maxwell GPU
- 3GB LPDDR4 memory
- 32GB or 64GB storage options
- USB Type-C
- 8MP rear camera and 2MP front camera
- Android 6.0 Marshmallow

KEY FINDINGS

- After much heating and some heavy duty suction, we have lift-off! Alas, we seem to be tethered to the launchpad: A thin cable for the front-facing camera keeps us from immediate opening success. Once the camera cable is dispatched, we can open the Pixel C, with the wide display data ribbon cable still attached.
- Unlike most tablets, the Pixel C's front-facing camera assembly is on the display, not within the unibody chassis. That makes for an annoying extra cable to disconnect when opening it. A daughterboard connects the display data cable, and is host to the Synaptics touchscreen controller.
- The speakers' backs are covered in spring contacts that all connect to the back of the case—perhaps for grounding, or conducting Wi-Fi to the antennas. The speakers are home to stuck-on antennas, so replacing the speakers probably means extra work in the form of peeling and re-sticking.
- After a honeymoon of modular parts, we encounter a rough patch: a glued motherboard. We opt for some heat action, and finally wrest the mobo from two adhesive pads, some non-stick foam padding, and two strips of conductive foam.
- We're ready to tackle that hefty battery. After some serious heating, we start scraping with a plastic card. Even at the shallowest of angles, we start to curl the battery like pencil shavings. This is some tough adhesive. We decide we don't want a Li-Ion battery explosion, and stop here.
- Repairability Score: 4 out of 10 (10 is best): Many parts, including the USB-C port, are modular, and can be replaced independently. The mobo is glued to the rear case. Strong adhesive holds the battery to the case, too, complicating replacement. The fused display must be removed to access interior parts—no easy task, thanks to tough adhesive.

Make a Pi MusicBox AirPlay Receiver

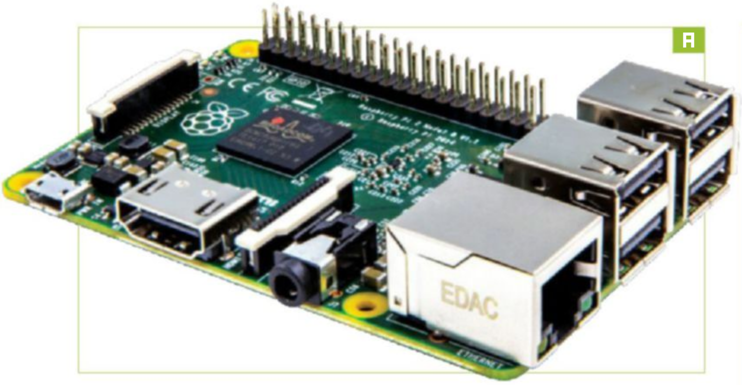
YOU'LL NEED THIS

RASPBERRY Pi 2
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

Pi MUSICBOX
Go to http://bit.ly/MopidyPiMusicBoxAnswers for a whole heap of help.

AIRPLAY REMAINS a great way of wirelessly piping music through your home, but even basic AirPlay speakers come with a hefty price tag attached. In many cases, you'll already have a perfectly serviceable stereo system in place, so why spend a fortune on another speaker (or pair of speakers), when you can put together your own wireless AirPlay receiver for around $65? Better still, why limit yourself to AirPlay, when your receiver can do so much more?

We were inspired to try this project by a desire to make full use of a 25-year-old Pioneer stereo system that sounds as good as the day we bought it. We had reasonable hopes the receiver would make good use of the stereo's sound capabilities, but even we couldn't have foreseen just how spectacular the results would be. –NICK PEERS



1 GETTING STARTED

This project will cost you around $65 for all the parts, and there is some soldering involved, but the good news is that, once complete, you'll have a full-blown music receiver that can do much more than act as an AirPlay receiver.

›› Your AirPlay receiver will consist of a number of components, and you're free to trade up or down as you see fit. We picked the Pi Zero because it's so cheap, but you can easily adapt this project to the Raspberry Pi 2 [**Image A**]. (The current version of Pi MusicBox isn't compatible with the Pi 3, but it can be made to work—head to http://bit.ly/MopidyPiMusicBoxAnswers for information on this and other issues.) Doing so may cost more, but you avoid the need to do any soldering, and you even have the option of turning your AirPlay receiver [**Image B**] into a standalone system—you just need some speakers. (Fancy building a full-blown AirPlay stereo system? Pair a full-size Raspberry Pi with the Pi-DigiAMP+ ($82) and Pi-CASE+ ($22) from www.iqaudio.com, along with a 15V power brick ($35) from www.modmypi.com, and all you need to supply are speakers.)

2 GRAB THE GEAR

If you're following our project, however, you need the Pi Zero ($5), then you need to go to www.thepihut.com to purchase the Essential Raspberry Pi Zero Kit ($8, for the adapters and GPIO header), a USB Wi-Fi dongle ($11), and Pi Zero power adaptor ($8). Visit www.iqaudio.com to purchase the Pi-DACZero ($21), which offers twin phono outputs to hook up to your stereo.

›› You'll want a case for your receiver, and IQ Audio sells its own dedicated case for $15, which will push the cost of your receiver up, but if you don't mind the Pi-DACZero sitting on top of your case, you'll find a range of alternative cases online. Finally, you need a class 10 microSD card, which only needs to be 1GB in size, although if you plan to store music on the Pi Zero, you'll want it to be 16GB or bigger. Shop around to limit your cost to $7, then visit the Audio & Video section of Lindy (www.lindy.com) if you need a suitable cable (about $4).

3 SOLDERING ON

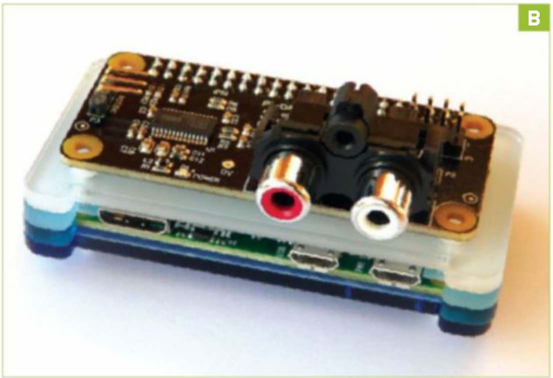
The biggest task you face with the Pi Zero is soldering the GPIO header on [**Image C**]—this is required to connect up the DAC. If you're just starting out, check your local hardware store for a soldering iron, stand, suitable solder, and tub of flux—it should all come to about $15.

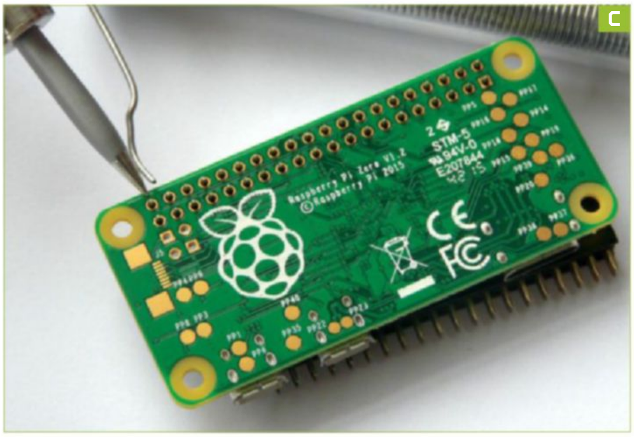
›› Make sure the Pi Zero is the right way up, and insert the male header into the correct holes at the back of the board, with the shortest pins facing down. If you turn the Pi Zero over, you should see the pins protrude above the board, which is where you'll solder them into place. Use something to prop up the board while you apply the solder.

›› Place the soldering iron in the stand, dampen the cloth on the stand, switch on the iron, and wait for it to heat up. While waiting, dip the end of the solder wire into the flux, as this helps prevent it from sticking. When the soldering iron is hot enough, dip its tip into the flux, too.

4 GET STUCK IN

Now place the tip against one of the corner pins. Introduce the solder to it, wait for a bit to melt off, and fix the pin in place. Now repeat for the pin in the opposite corner. At this point, switch off the iron and wait a




C

few seconds for the Pi Zero to cool down. Pick it up and turn it over to verify the solder has taken, and the pins remain straight.

›› Flip the Pi Zero over again, and solder the other 38 pins [**Image D**]. Remember to clean the soldering iron tip on the damp pad every now and then, plus keep adding flux to prevent sticking. There's a handy online video for soldering on the GPIO header at https://youtu.be/MSGIrtGMYRM that we strongly recommend you watch.

›› If you purchase a Pibow case—as we originally did—you'll find it seals off the slot to the micro SD card. This isn't a deal-breaker, but you will need to insert the card into your Pi Zero and test it before constructing the case. To do so, follow the first three steps of the walkthrough (pg. 65) to prepare your microSD card with Pi MusicBox. At time of writing, the latest version (0.6) isn't compatible with the Pi Zero, but we found a modified build that works perfectly—this is the version you download in the walkthrough—or visit www.pimusicbox.com to see if a newer, compatible version is ready.

›› Once your microSD card is ready, insert it, attach the Wi-Fi adapter, and switch the Pi Zero on. You don't need a keyboard or monitor, as Pi MusicBox can work headless, which enables you to access it remotely using any web browser [**Image E**] or via SSH (see "Access via SSH," pg. 64). Go to http://musicbox.local to do so.

5

FINAL CONNECTIONS

Once you've verified everything's working correctly, click "System," and choose "Shutdown" to power off the Pi Zero. Disconnect all cables, leave the microSD card in place, then assemble the Pibow case if you're using it. Once you plug the Pi-DACZero into the Pi Zero's GPIO header, it should fit securely.

›› You can now power the Pi Zero back on, and follow the final two steps of the walkthrough (see pg. 65) to finish the basic configuration. Connect the Pi-DACZero to your stereo, set the correct input, then test the connection using an app or program that supports AirPlay. When selecting an AirPlay device, you should see "MusicBox" is listed—select this, and enjoy your music full-blast through your stereo.

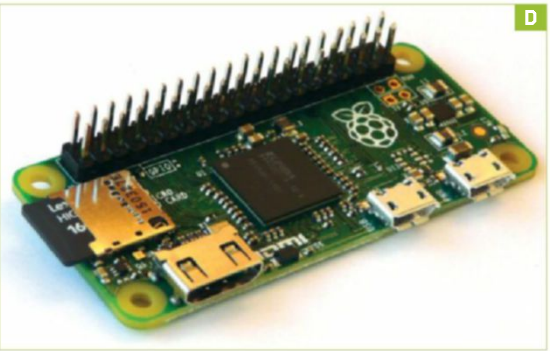
6

ADDING SERVICES

Now you've got your AirPlay music receiver up and running, it's time to see what else you can do with it. First, let's examine what other streaming services Pi MusicBox supports. Go to http://musicbox.local/settings and expand the "MusicBox" section. You'll see a switch that enables support for streaming from your DLNA/uPNP/OpenHome media server. Flick this switch on and look for "MusicBox" as a streaming option when playing music from your server. For example, Emby users will see "MusicBox—DLNA" appear as a playback device under "Select Player," via the Emby web interface, enabling you to send music to it direct from the server.

›› Pi MusicBox also enables you to connect your receiver to a number of different online services, including Spotify (Premium users only), SoundCloud, YouTube (audio only), and Last.fm—just follow the instructions to connect them, typically by flicking a switch, adding the requisite token, or by providing your user account details. You'll have to reboot Pi MusicBox each time you save your settings, so consider adding multiple accounts at once to save time. Once you've connected to a service, you'll be able to access it via the "Browse" section of the web interface.

›› You can stream podcasts and radio through your receiver, too, by selecting "Browse → TuneIn → Local Radio," to see if your favorite station is covered. Failing that, go to "Streams," where you can connect sources

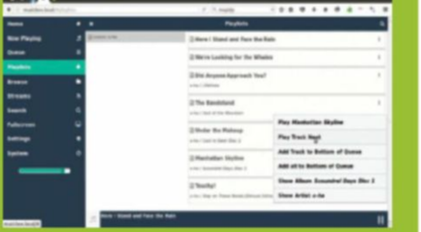

D

PLAYLIST SUPPORT

While Pi MusicBox is capable of playing M3U playlists, there is—as yet—no means of actually creating and managing them within the server. Thankfully, playlist creation is built into various supported clients, including both mobile apps and web-based front ends.

One of the best apps we've found for this job is Mopidy Mobile on Android, but you'll need to connect it to Pi MusicBox manually using your Pi Zero's IP address (get this via SSH using `ifconfig` if necessary). Once done, you'll not only have complete control over your Pi Zero, but you can set up playlists relatively easily, too: Click the "Edit" button (the pencil icon), followed by the "Create" button, give your playlist a suitable name, and tap "Save," then "Done."

Next, switch to the Library section, browse for a track to add, tap the "Menu" button next to it, and choose "Add to playlist." Tap your playlist, then repeat for other tracks. You can't remove tracks from the playlist, or edit the running order with Mopidy Mobile, so choose with care. Once created, the playlist is available everywhere—including the main Pi MusicBox web interface.



that provide compatible streams in MP3, M3U, ASX, and similar formats. Simply enter the URL into the box, and click "Play" to listen. If it works, you can also provide a name, and click "Save" for future access. A number of streams are set up by way of example—you can try these, or clear them to provide room for your own.

7

STORE MUSIC LOCALLY

Pi MusicBox can also play music stored locally, either on its own internal microSD card, or via a FAT-formatted USB drive, although the latter necessitates the use of a hub for your Pi Zero. You'll need to choose the Broadcom Hub and Wi-Fi Adapter from www.pi-supply.com instead of the Wi-Fi adapter when building your Pi Zero. It costs about $14.

» There are two good reasons for using local storage. First, if your Wi-Fi signal isn't particularly strong, you may find streaming problematic, whereas locally stored media plays fine, so long as the connection is good enough to receive commands. Second, Pi MusicBox supports a wide number of audio formats, including the audiophile-preferred lossless FLAC format. If quality is important, and you don't mind each album consuming around 300–400MB of space, FLAC really is the best way to listen to your music.

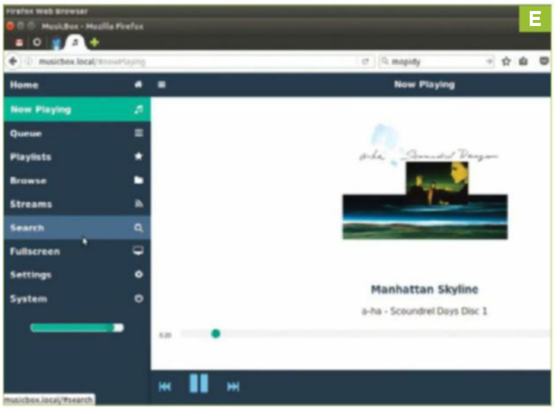
» If you've not yet ripped your CDs, you'll find most ripping tools support FLAC, albeit not by default. If you're a Rhythmbox user, for example, you need to select "Edit → Preferences → Music tab" to pick it as your preferred format. If quality isn't as important, however, the default Ogg Vorbis format is supported by Pi MusicBox, as are MP3 and AAC, all of which enable you to store more albums on your card or USB drive.

» If you plan to store music on the microSD card, make sure it's large enough (16GB minimum, but 64GB or more is recommended). You first need to instruct Pi MusicBox to make all that extra space available. To do this, from the web interface, choose "Settings → Music Files." Flick the "Resize filesystem" switch to "On," and reboot. Once done, return to "Music Files," and make sure "Scan Music Files" is switched to "On" whenever you add new music to the card or a USB drive.

8

TRANSFER YOUR MUSIC

Once you've ripped your music to your PC, transferring it to your Pi MusicBox is done one of two ways: If your network connection is strong, the quickest and most convenient way is to open your file manager and browse for "MusicBox.local" over your network. You'll find a shared Music folder, inside which you copy your files using the traditional artist/album/track hierarchy. Alternatively, power down your Pi Zero, and connect the microSD card direct to your system. You'll find two partitions are mounted—select "RPI0," browse to "Music\MusicBox," and copy your music into here.



» Pi MusicBox is based on the Mopidy music server, which provides support for services through custom-written extensions. At the time of writing, Pi MusicBox hadn't been updated for about a year. In the meantime, Mopidy has received a number of major updates, while Pi MusicBox's underlying Raspbian installation is based on the old "Wheezy" release. The author has revealed he's working on a new Jessie-based version that should not only be officially compatible with the Pi Zero (and Pi 3), but should also update Mopidy to a later version.

» One benefit of running the latest version of Mopidy is that it's an extremely versatile beast, and if you take a trip to https://docs.mopidy.com, you'll see a large section dedicated to Extensions, where you'll find more ways to expand your music receiver. One particular bonus is the ability to swap out the default web client for something more attractive. A number of alternatives have been developed, but while it's tempting to try them with your current installation, don't—doing so will upgrade Mopidy to 2.0, which will break your system. Instead, check out the guide to installing Raspbian Jessie and Mopidy 2.0 from scratch. If you're impatient to try the latest version of Mopidy, you can build your own custom installation using Jessie Lite as the back end. A full guide can be found at http://mopidy.readthedocs.org—expand "Installation," and select "Raspberry Pi" for a step-by-step guide. ⏻

ANOTHER PI TUTORIAL NEXT MONTH

ACCESS VIA SSH

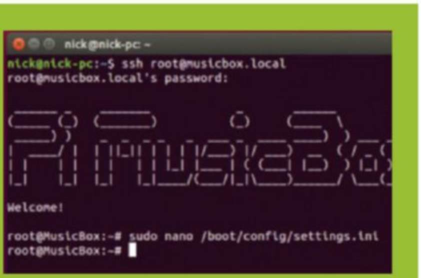
Should you want to access the underlying operating system behind Pi MusicBox, you can do so via SSH. First, enable SSH in Pi MusicBox via "Settings" under "Network." We also recommend changing the default password ("PiMusicBox"), which can be done from the MusicBox section. Click "Update settings (reboot)," and once Pi MusicBox is up and running again, open Terminal on your PC, and set up an SSH connection with the following command: `ssh root@musicbox.local`. Type `yes` when prompted, then enter the root password.

Once you've logged in, you can access the PiMusicBox configuration file by using the following command:

```
sudo nano /boot/config/settings.ini
```

Here you can quickly tweak the same settings you see via the web interface. Note: The file itself is stored in plain text for all to see, hence the importance of changing the root password.

You can also use the command line to update the underlying OS—we don't recommend it, unless necessary, as it's been known to break Pi MusicBox—plus install additional packages, if required.



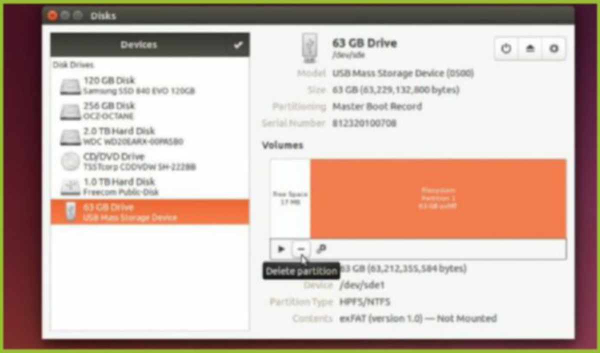
```
nick@nick-pc:~$ ssh root@musicbox.local
root@musicbox.local's password:

Welcome!

root@MusicBox:~# sudo nano /boot/config/settings.ini
root@MusicBox:~#
```

You could, for example, follow the guide at http://bit.ly/MusicBoxToBluetooth to see if you can add Bluetooth support to Pi MusicBox. You can also access Pi MusicBox's underlying operating system through SSH, but be warned, it'll expose its underlying insecurities.

SET UP PI MUSICBOX

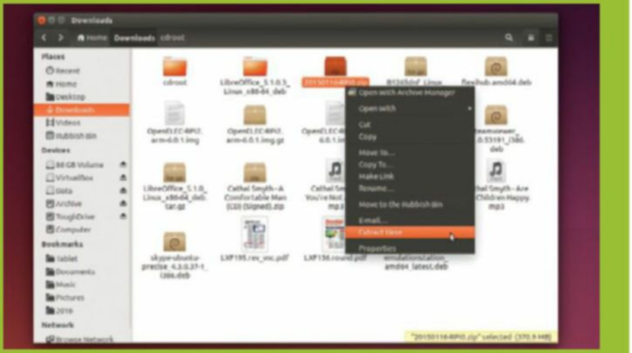

Disks
Devices
Disk Drives
Delete partition

120 GB Disk
Samsung SSD 840 EVO 120GB
256 GB Disk
OCZ-OCTANE
2.0 TB Hard Disk
WDC WD20EARX-00PASB0
CD/DVD Drive
TSSTcorp CDDVDW SH-222BB
1.0 TB Hard Disk
Freecom Public Disk
63 GB Drive
USB Mass Storage Device

63 GB Drive
/dev/sde
Model USB Mass Storage Device (0500)
Size 63 GB (63,229,132,800 bytes)
Partitioning Master Boot Record
Serial Number 812320100708
Volumes
Free Space 1.1 MB
Filesystem Partition 1 63 GB exFAT
Size 63 GB (63,212,355,584 bytes)
Device /dev/sde1
Partition Type HPFS/NTFS
Contents exFAT (version 1.0) — Not Mounted

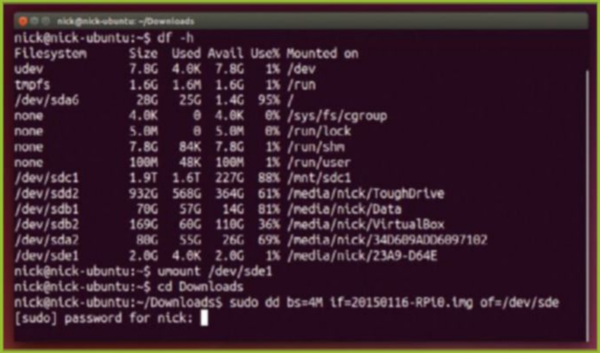
1. PREPARE YOUR MICROSD CARD

Connect a microSD card to your PC via a USB adapter. If you get an error about exFAT, you need to format it as FAT32. Open Disks from the Dash, and select your card. You'll see an exFAT partition—select it and click "-" to delete it. Click "+" and set the partition size to 2048MB, choose "FAT," and click "Create."


Downloads
Home
Downloads
Places
Recent
Home
Desktop
Downloads
Videos
Rubbish Bin
Devices
Bookmarks
Network
Open with Archive Manager
Open with
Cut
Copy
Move to...
Copy To...
Make Link
Rename...
Move to the Rubbish Bin
Email...
Extract Here
Properties
"20150116-RPi0.zip" selected (370.9 MB)

2. DOWNLOAD PI MUSICBOX

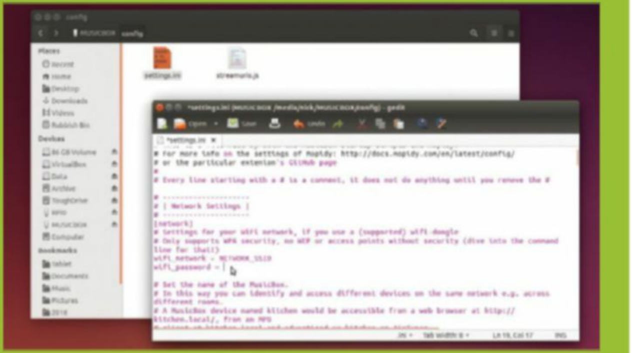
You need a specially built Pi Zero-friendly build of Pi MusicBox—download the 350MB image from http://bit.ly/pimusiczero. Once saved to your Downloads folder, open Nautilus, browse to the folder, right-click "20150116-RPi0.zip," and choose "Extract Here." Now open a Terminal window, and enter `df -h`.


nick@nick-ubuntu: ~/Downloads

```
nick@nick-ubuntu:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            7.8G  4.0K  7.8G   1% /dev
tmpfs           1.6G  1.6M  1.6G   1% /run
/dev/sda6        28G   25G  1.4G  95% /
none            4.0K     0  4.0K   0% /sys/fs/cgroup
none            5.0M     0  5.0M   0% /run/lock
none            7.8G   84K  7.8G   1% /run/shm
none            100M   48K  100M   1% /run/user
/dev/sdc1       1.9T  1.6T  227G  88% /mnt/sdc1
/dev/sdd2       932G  568G  364G  61% /media/nick/ToughDrive
/dev/sdb1        70G   57G   14G  81% /media/nick/Data
/dev/sdb2       169G   60G  110G  36% /media/nick/VirtualBox
/dev/sda2        80G   55G   26G  69% /media/nick/34D609ADD6097102
/dev/sde1       2.0G  4.0K  2.0G   1% /media/nick/23A9-D64E
nick@nick-ubuntu:~$ umount /dev/sde1
nick@nick-ubuntu:~$ cd Downloads
nick@nick-ubuntu:~/Downloads$ sudo dd bs=4M if=20150116-RPi0.img of=/dev/sde
[sudo] password for nick: █
```

3. WRITE PI MUSICBOX IMAGE

Identify your card's 2GB partition ("/dev/sde1" in our example), and type `umount /dev/sde1` to unmount it. Type `cd Downloads`, then the following (substitute "/dev/sde" with the mount point for your card): `sudo dd bs=4M if=20150116-RPi0.img of=/dev/sde`. Wait for the image to be written.


config
MUSICBOX
config
settings.ini
streamuris.js
*settings.ini (MUSICBOX /media/nick/MUSICBOX/config) - gedit
Open
Save
Undo
*settings.ini
Ln 19, Col 17
INS

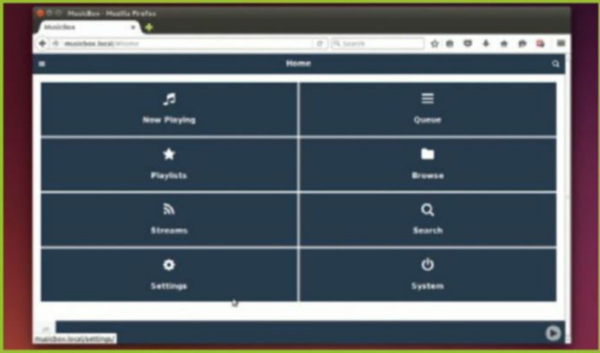
```
# For more info on the settings of Mopidy: http://docs.mopidy.com/en/latest/config/
# or the particular extension's GitHub page
#
# Every line starting with a # is a comment, it does not do anything until you remove the #

# --------------------
# | Network Settings |
# --------------------
[network]
# Settings for your wifi network, if you use a (supported) wifi dongle
# Only supports WPA security, no WEP or access points without security (dive into the command
line for that!)
wifi_network = NETWORK_SSID
wifi_password = 

# Set the name of the MusicBox.
# In this way you can identify and access different devices on the same network e.g. across
different rooms.
# A MusicBox device named kitchen would be accessible from a web browser at http://
kitchen.local/, from an MPD
```

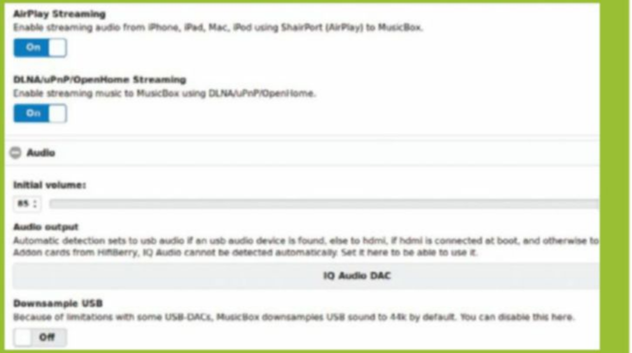
4. ADD WI-FI DETAILS

Unplug the USB adapter, then plug it back in. Two windows open, pointing at different partitions. Open the "config" folder under "MUSICBOX," and double-click "settings.ini." Find the [network] section, and add your Wi-Fi network's SSID to `wifi_network =`. Type your network password next to `wifi_password =`.


MusicBox - Mozilla Firefox
MusicBox
musicbox.local/#home
Search
Home
Now Playing
Queue
Playlists
Browse
Streams
Search
Settings
System
musicbox.local/settings

5. BOOT AND TEST

Select "Save," exit the text editor, and click "Eject," before unplugging the USB adapter. Insert the microSD card into your Pi Zero, and switch on. A flashing green light indicates it's booting correctly. Wait a few minutes, open your browser, and type "http://musicbox.local" into the URL navigation field.



AirPlay Streaming
Enable streaming audio from iPhone, iPad, Mac, iPod using ShairPort (AirPlay) to MusicBox.
On

DLNA/uPnP/OpenHome Streaming
Enable streaming music to MusicBox using DLNA/uPnP/OpenHome.
On

Audio

Initial volume:
85

Audio output
Automatic detection sets to usb audio if an usb audio device is found, else to hdmi, if hdmi is connected at boot, and otherwise to
Addon cards from HifiBerry, IQ Audio cannot be detected automatically. Set it here to be able to use it.
IQ Audio DAC

Downsample USB
Because of limitations with some USB-DACs, MusicBox downsamples USB sound to 44k by default. You can disable this here.
Off

6. FIRST TWEAKS

Go to "Settings → Audio," click the "HDMI" menu, and choose "IQ Audio DAC." Turn "Downsample USB" off. Expand the MusicBox section, and turn "Airplay Streaming" on. Scroll to the bottom, and click "Update settings (reboot)." Once booted, connect the Pi DAC Zero to your stereo's auxiliary input. You're ready to stream!

Recover Lost or Deleted Files

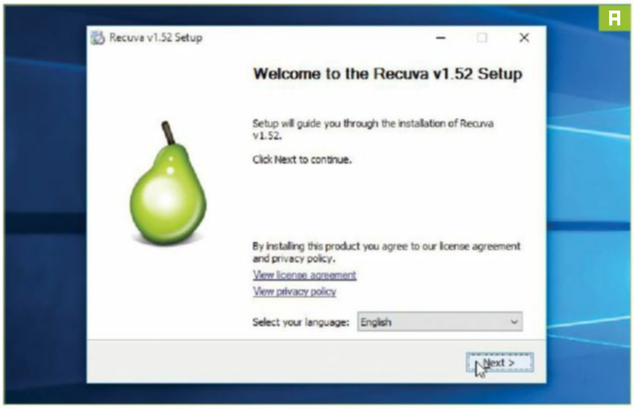
YOU'LL NEED THIS

RECUVA
Download this free app from www.piriform.com/recuva.

WE'VE ALL DELETED FILES BY MISTAKE, and immediately panicked, because while deleting them is easy to do, recovering them isn't always that straightforward.

The good news is that when you empty the Windows Recycle Bin, the files aren't really destroyed. In fact, what Windows does is earmark the space occupied by the "deleted" files as empty space for new data. This makes it possible to recover the files, so long as new data hasn't already been written over the space.

Recuva is a free, feature-rich tool that helps recover accidentally deleted files. In addition to hard disks, it can also be used to recover data on USB drives, SD cards, and smartphones connected to your computer. It can recover data from formatted drives, too. If that wasn't enough, Recuva can even recover deleted emails from your mail client. Let's get started! **–MAYANK SHARMA**



Recuva v1.52 Setup

Welcome to the Recuva v1.52 Setup

Setup will guide you through the installation of Recuva v1.52.

Click Next to continue.

By installing this product you agree to our license agreement and privacy policy.
View license agreement
View privacy policy

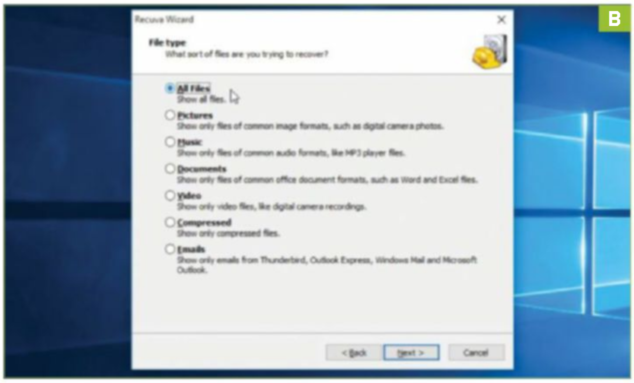
Select your language: English

1 DOWNLOAD AND INSTALL

Head to www.piriform.com/recuva and click "Free Download" to grab the application [**Image A**]. Run the installer to install the app. While the default installation options work for most users, make sure you remember to deselect the option to install any additional application when prompted.

2 RECOVERY WIZARD

When you launch the app, it fires up a recovery wizard. Ensure that the storage device where your deleted files are kept is connected to the computer. If your deleted files are stored on an external drive, such as a USB stick or a memory card, remember to connect them to your PC via a USB cable or card reader.



Recuva Wizard

File type
What sort of files are you trying to recover?

● **All Files**
Show all files.

○ **Pictures**
Show only files of common image formats, such as digital camera photos.

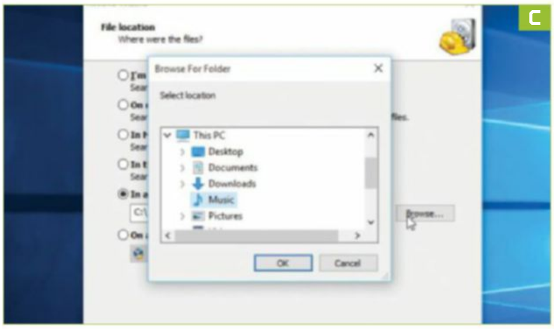
○ **Music**
Show only files of common audio formats, like MP3 player files.

○ **Documents**
Show only files of common office document formats, such as Word and Excel files.

○ **Video**
Show only video files, like digital camera recordings.

○ **Compressed**
Show only compressed files.

○ **Emails**
Show only emails from Thunderbird, Outlook Express, Windows Mail and Microsoft Outlook.



File location
Where were the files?

Browse For Folder

Select location

3 FILE TYPE

In the next screen, the program asks you to select the type of files you are trying to retrieve. You can only check one of the options [**Image B**]. If you wish to retrieve two or more types, you need to select "All Files." This retrieves all deleted files, but you can sort out the ones you don't need later.

4 SELECT LOCATION

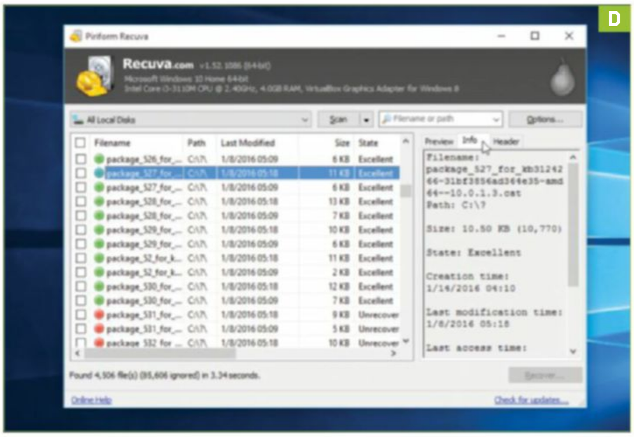
After selecting the type of file you wish to retrieve, the program prompts you to select the location where you want to retrieve the files from. The screen lists several options. The default option searches your entire computer, while the second option looks for deleted files inside any removable drives.

5 BROWSE LOCATION

Instead of searching your entire computer, you can save time and look for deleted files inside a specific location by selecting the second-to-last option [**Image C**]. Now click "Browse," and point Recuva to a particular folder on the computer. Select the last option if you wish to look for files on an optical disc.

6 INITIATE THE SCAN

That's all the information Recuva needs to start hunting for deleted files. Click "Start" in the next screen to get going. Do not toggle the option marked "Deep Scan" at this stage. This option kicks off an intensive and time-consuming scan, and should only be used if you can't find the files using the regular process.

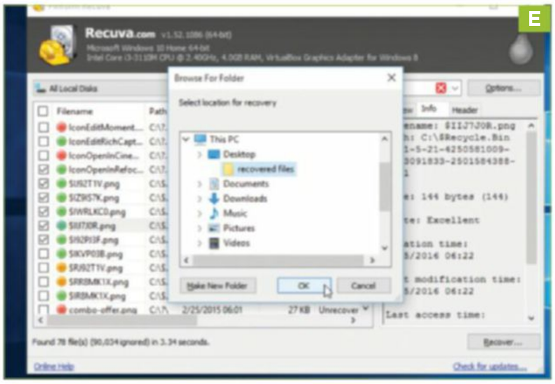


7 ANALYZE RESULTS

A regular scan usually only takes a few seconds. When it's finished, Recuva lists all the deleted files that it has dug up [**Image D**]. The list is normally fairly long and exhaustive, especially if you asked the application to look for all types of deleted files back in Step 3.

8 SWITCH TO ADVANCED MODE

Because the recovered files don't retain their original names, you'll need help identifying them. Click "Switch to advanced mode." This splits the interface, and shows three tabs in the right-hand pane. Use these to preview the files, and read their metadata information, such as size, state, creation time, and so on.



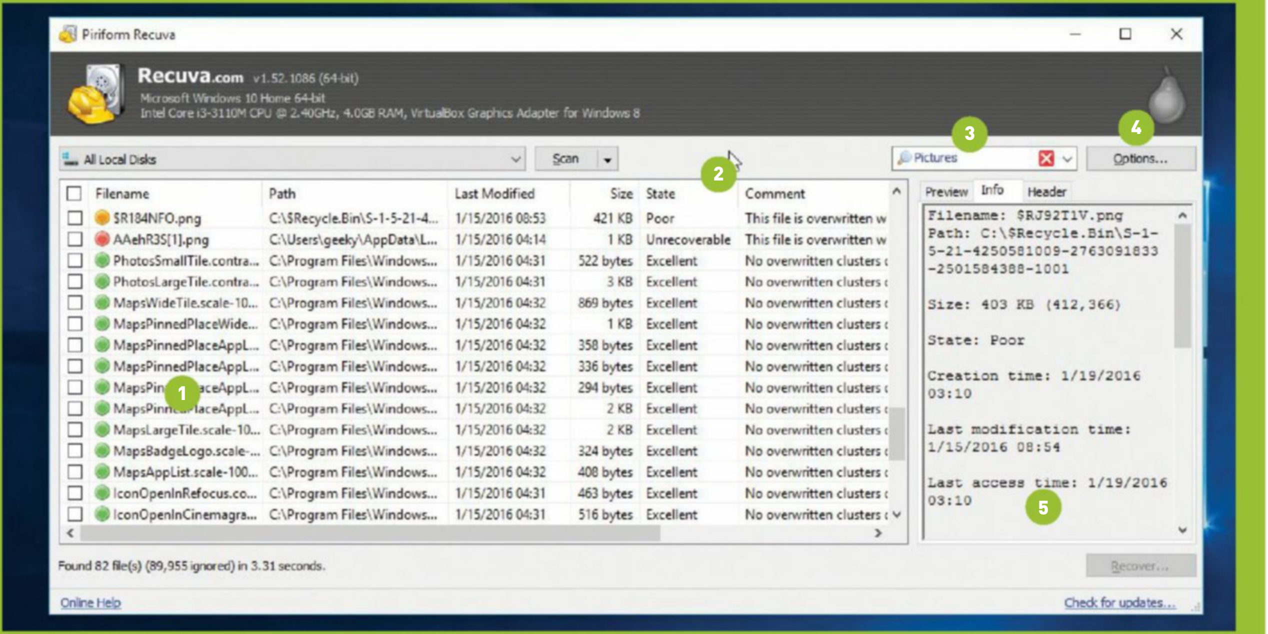
9 NARROW DOWN RESULTS

You can also rein in the results by limiting their scope. Use the pull-down menus in the advanced mode. The first menu enables you to switch drives, while the third can be used to only show files of a particular media type. When you find files you recognize, toggle the checkbox adjacent to the files you wish to recover.

10 RECOVER FILES

Now click "Recover." Recuva asks you where you wish to save the recovered files [**Image E**]. This folder should be on a different drive from the one you've scanned for deleted files. That's it! This folder now contains all the recovered files for you to rename and move as you please. ⏻

RECUVARY TIME


Piriform Recuva
Recuva.com v1.52.1086 (64-bit)
Microsoft Windows 10 Home 64-bit
Intel Core i3-3110M CPU @ 2.40GHz, 4.0GB RAM, VirtualBox Graphics Adapter for Windows 8
All Local Disks
Scan
Pictures
Options...
Preview
Info
Header
Recover...
Online Help
Check for updates...
1
2
3
4
5

☐	Filename	Path	Last Modified	Size	State	Comment
☐	$R184NFO.png	C:\$Recycle.Bin\S-1-5-21-4...	1/15/2016 08:53	421 KB	Poor	This file is overwritten w
☐	AAehR3S[1].png	C:\Users\geeky\AppData\L...	1/15/2016 04:14	1 KB	Unrecoverable	This file is overwritten w
☐	PhotosSmallTile.contra...	C:\Program Files\Windows...	1/15/2016 04:31	522 bytes	Excellent	No overwritten clusters (
☐	PhotosLargeTile.contra...	C:\Program Files\Windows...	1/15/2016 04:31	3 KB	Excellent	No overwritten clusters (
☐	MapsWideTile.scale-10...	C:\Program Files\Windows...	1/15/2016 04:32	869 bytes	Excellent	No overwritten clusters (
☐	MapsPinnedPlaceWide...	C:\Program Files\Windows...	1/15/2016 04:32	1 KB	Excellent	No overwritten clusters (
☐	MapsPinnedPlaceAppL...	C:\Program Files\Windows...	1/15/2016 04:32	358 bytes	Excellent	No overwritten clusters (
☐	MapsPinnedPlaceAppL...	C:\Program Files\Windows...	1/15/2016 04:32	336 bytes	Excellent	No overwritten clusters (
☐	MapsPin aceAppL...	C:\Program Files\Windows...	1/15/2016 04:32	294 bytes	Excellent	No overwritten clusters (
☐	MapsPinn laceAppL...	C:\Program Files\Windows...	1/15/2016 04:32	2 KB	Excellent	No overwritten clusters (
☐	MapsLargeTile.scale-10...	C:\Program Files\Windows...	1/15/2016 04:32	2 KB	Excellent	No overwritten clusters (
☐	MapsBadgeLogo.scale-...	C:\Program Files\Windows...	1/15/2016 04:32	324 bytes	Excellent	No overwritten clusters (
☐	MapsAppList.scale-100...	C:\Program Files\Windows...	1/15/2016 04:32	408 bytes	Excellent	No overwritten clusters (
☐	IconOpenInRefocus.co...	C:\Program Files\Windows...	1/15/2016 04:31	463 bytes	Excellent	No overwritten clusters (
☐	IconOpenInCinemagra...	C:\Program Files\Windows...	1/15/2016 04:31	516 bytes	Excellent	No overwritten clusters (

```
Filename: $RJ92T1V.png
Path: C:\$Recycle.Bin\S-1-
5-21-4250581009-2763091833
-2501584388-1001

Size: 403 KB (412,366)

State: Poor

Creation time: 1/19/2016
03:10

Last modification time:
1/15/2016 08:54

Last access time: 1/19/2016
03:10
```

Found 82 file(s) (89,955 ignored) in 3.31 seconds.

1. RECOVERED FILES
The recovered files usually have different names from their original ones.

2. FILE STATE
Not all files are recoverable. This column helps you to determine whether a file is recoverable or not.

3. MEDIA TYPE
Use this pull-down menu to narrow down the search results based on the file type.

4. OPTIONS
Click this to tweak the app's behavior.

5. FILE INFORMATION
You'll find various metadata about a selected file to help you identify it.

Design Yourself Some "Hope"

YOU'LL NEED THIS

AFFINITY DESIGNER
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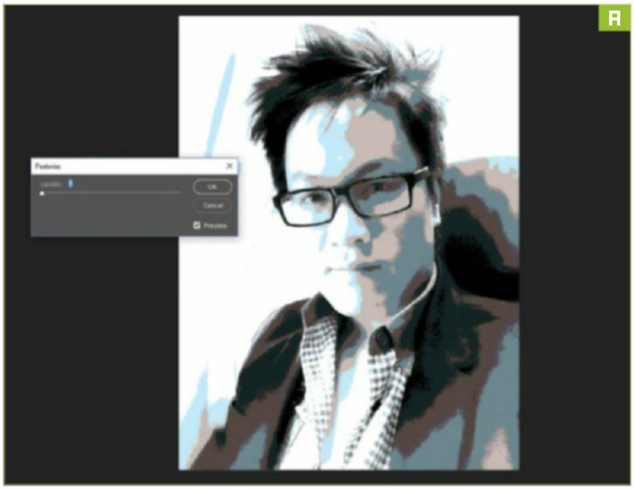
ADOBE PHOTOSHOP
Subscribe at www.adobe.com.

A SUITABLE PHOTO
You need a portrait to work on.

SHEPPARD FAIREY'S FAMOUS, maybe even iconic, poster from the 2008 US presidential election became so well known it even has its own Wikipedia entry. The original is based on a 2006 photo by former Associated Press freelance photographer Mannie Garcia, and a version of it was added to the Smithsonian collection in 2009. Showing Barack Obama in blue, red, and beige, the original wording was "Progress," but it was changed to "Hope" before release.

In these times of international turmoil, we could all do with a little hope, so here's how to recreate the poster's look with your own photo. We're going to use Affinity Designer for this, Serif's vector design tool that's been out on the Mac for some time, but has recently come to Windows, and is available as a free beta. We'll use Photoshop for some steps, and you could achieve the same final result with Adobe Illustrator. Affinity also has a photo-editing app on Mac, but it hasn't come to Windows yet—though we have reason to hope it's on its way. **–IAN EVENDEN**



1 REDUCE COLORS

Once you've chosen a suitable photo of someone looking rugged, wise beyond their years, and perhaps a little sensitive (we couldn't find one like that, but this shot of Tuan was conveniently on our desktop), you need to reduce the number of colors in it. Open the file in Photoshop, and select "Posterize" from "Image → Adjustments." We chose five levels [**Image A**].

2 SEPARATE INTO PARTS

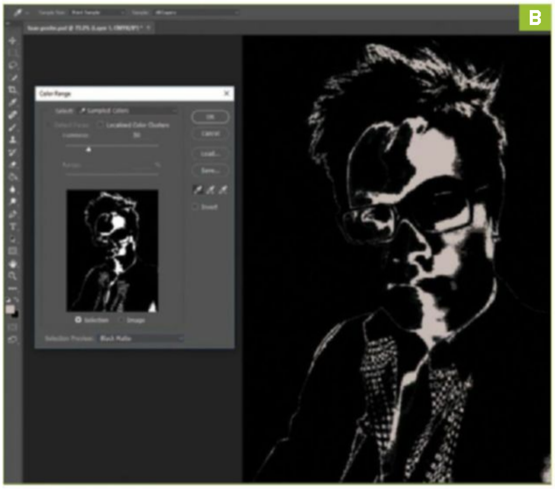
From here, we need to separate the image into its constituent parts. If you've got a week to spare, you can go round all the edges with the Pen tool, and draw a path around each area of color. There is a quicker way, however: Color Range. Head to "Select → Color Range," and use the dropper tool to select one of the colors in your image [**Image B**]. We set the Fuzziness slider to 50, so it picks up dark and light shades of our chosen color. Hit "OK," then use Refine Edge to smooth your selection. You need to do this for each of the colors Posterize produced, saving each selection as a path each time (click the button at the bottom of the Paths palette to turn a selection into a separate path). Rename your paths with their color as you go, otherwise it's going to get really confusing. We've separated the white part of Tuan's face from the background here, by hand, so it stands out more later.

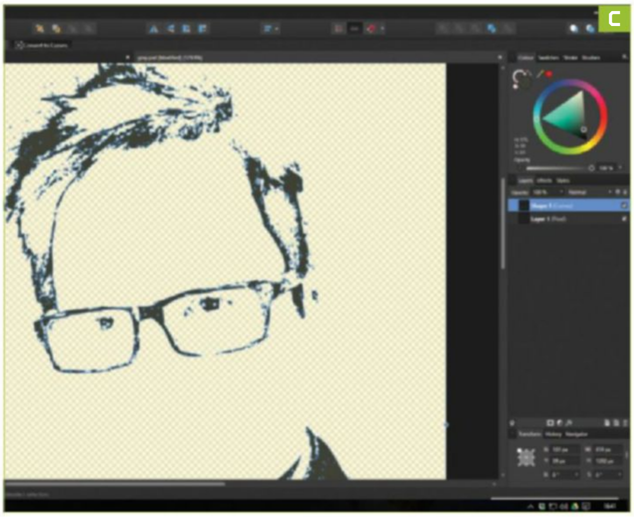
3 SAVE PATHS AS NEW DOCUMENTS

Affinity is a little finicky about importing paths from Photoshop. You need to convert them into shapes before exporting. Select the path at the top of your palette, then the Pen tool from the toolbar. Set your foreground color to the same as the color layer, or something close, then head to the top of the interface, where the tool-specific options live, and click the button marked "Shape." Create a new document the same size as your original, and copy your new shape layer into it. Save the document as a PSD file with the name of the color. Do this for every path you created, making a new document each time.

4 CONVERT TO CURVES

Open Affinity and create a new document. Size isn't hugely important, as vector art is resolution-independent, so we went for A4. Save it, then open one of your PSD files. This sent our quad-core i7 into a bit of a frenzy, and we had time to go off for a drink while it thought about it, but eventually your PSD will open, layers intact, on a separate tab to your blank document. Select the shape you created in the last step, then click "Convert to Curves" at the top of the interface [**Image C**]. This is important, as





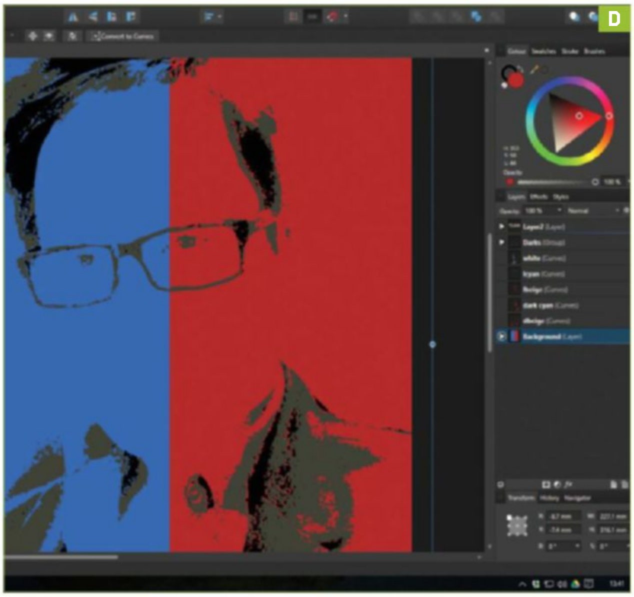
Affinity finds its own curves much easier to work with than the paths exported by Photoshop, and moving and resizing the shape becomes a jerky mess that's hard on the CPU fan if you don't do it. Copy your newly curve-converted shape into your new document, and resize it so it fills the space. Repeat for every PSD you created.

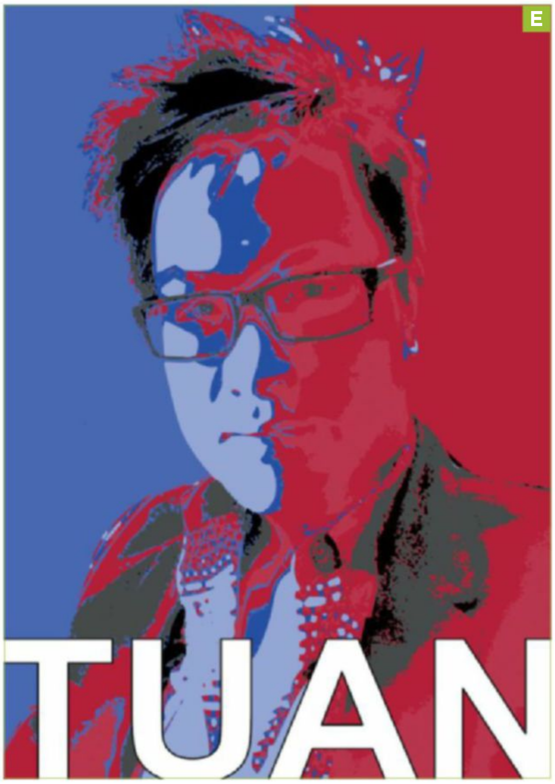
5 TWEAK COLORS

You'll now have your artwork approximately recreated in Affinity, but with every section, and therefore color, on a separate layer. The beauty of vector graphics is that nothing is set in stone, so we can select each layer and alter its color if we want. One of our original layers was a bit too yellow for our tastes, so we're going to alter it to red, to better match the Obama poster. The red and blue background needs to be duplicated, too, which we can do with just two rectangles.

6 CREATE COLORED RECTANGLES

Create a new layer and place it at the bottom of your stack. Choose the rectangle tool from the toolbar on the right, then drag a rectangle that completely fills, in fact overspills, your artwork. Keep it selected, then head to the "Fill" section of the tool-specific options palette at the top of the interface. Click the dropper, keep the mouse button held down, then drag it over the red color in your artwork, and release. It doesn't snap into red immediately, though—you need to click the red dot that's appeared next to the dropper first. Drag out a new rectangle that's the full height, but only about half the width, position it to the left (go to "View → Show Grid" if you need help), and use the same dropper to sample the blue color from your composition, and color your rectangle with it [**Image D**].





7 FINISHING TOUCHES

Now, all that's left is to use the text tool to add whatever message you like. We were going to go with "Hope," but felt "Tuan" was enough of a positive slogan for us [**Image E**]. As a finishing touch, you can shift the layers slightly to change the way they overlap, adding a hand-printed look to it. Save your work, then export it to share with the world. ⏻

WHAT IS A VECTOR?

Vector images, like those created in Designer or Adobe Illustrator, are made up of mathematical formulae, rather than individual pixels. The advantage is that they're not tied to a specific size or resolution, and can be blown up without losing quality. The disadvantage is that they're harder to make, requiring actual drawing skills, rather than a camera and some Photoshop know-how. Each path in your vector image has a beginning and an end, along with a formula that describes how it curves. It also has attributes, such as stroke (a line applied to the path itself) and fill (the color of the area the path encloses), attached to it. Enough of these overlaid can build up very complex artworks, given time and expertise.

BUILD IT

ZAK STOREY, STAFF WRITER

A Micro 4K Gaming Box

The question was asked: 4K gaming, microATX, SLI GTX 1080s—can it be done? Here's our response

LENGTH OF TIME: **3–4 HOURS**

LEVEL OF DIFFICULTY: **MEDIUM**

THE CONCEPT

THERE ARE CERTAIN THINGS in the world that must remain as absolute truths. Nothing can exceed the speed of light; peanut butter and jelly sandwiches have to be raspberry flavor; and PC gaming has to be done at 60fps. If these pillars fall, what are we but mere animals? And that brings us nicely to this Build It—or, more precisely, to one aspect of it. Let's face it, 4K monitors have been around for quite some time now. The increased screen real estate, coupled with a large panel size, tends to lead to a more enjoyable desktop experience. However, finding any graphics setup capable of pushing all of those 8,294,000 pixels more than 60 times a second has been nigh on impossible, certainly in AAA titles. At least, until now.

So, let's get to it. This particular rig was a challenge set by one of you. Last issue, we received a reader's letter asking about the concept of a microATX, 4K-capable gaming PC. The question, then, was simple: Is it possible, in today's age of 16nm FinFET graphics processors, to build a system capable of maintaining those crucial 60 frames per second at 4K in AAA titles, without fail, in a small enough form factor that you could keep it on your desk? Does SLI make sense in this regard, and what do you need to take into consideration when choosing your microATX chassis?

DESTINATION: 4K GAMING

WHERE TO START with such a unique build? You have two options: Either go all out, drop some cash on an Intel Core i7-6950X, two GTX 1080s, a Samsung 950 Pro, a 1,000W power supply, and a decent chassis—a build that ensures you keep your frame rates high and your credit score low. Or, you can go down the more logical route, something more effective as far as price-to-performance goes—an Intel Core i7-6800K/5820K, and two GTX 1070s or GTX 980 Tis. We thought about it long and hard—no, seriously we did, like for at least five minutes—and then we decided: To hell with logic! An Intel Core i7-6950X and two GTX 1080s it is, and a quick roundup of GTX 1070 SLI performance in next month's How To section will suffice.

But how do you house all this hardware in a footprint that you can pop on top of your desk? The choice was between a Corsair Carbide Air 240, with a compartmentalized interior and ease-of-use build features, or the more compact and stylish BitFenix Phenom M-ATX. The Phenom won out. The Intel Core i7-6950X is no chilly chip, whether or not you overclock it, and slapping two Founder's Edition cards in there, with blower-style shrouds, gives little breathing room. The Phenom has support for a 230mm BitFenix fan in the floor, and a 120mm fan in the rear, so we can use all the hardware we want without encountering any undesirable temperatures.

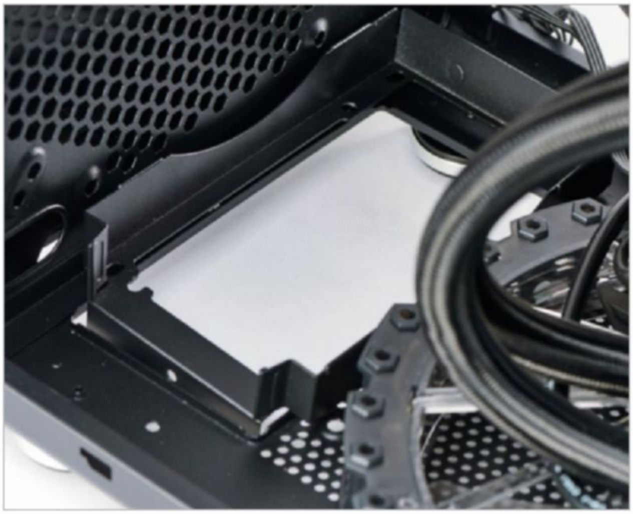
INGREDIENTS

PART		STREET PRICE
Case	BitFenix Phenom M	$91
Motherboard	ASRock X99M Extreme4	$184
CPU	Intel Core i7-6950X	$1,660
Memory	Corsair Vengeance LPX 16GB (4x 4GB) @ 2,400MT/s	$80
GPU	2x Nvidia GeForce GTX 1080	$1,398
PSU	Corsair HX1000i	$185
Storage	Samsung 950 Pro	$318
Cooling	Corsair H80i GT, 1x Noctua NF-F12 iPPC 120mm	$113
Total		$4,029

1

GHETTO MODIFICATIONS

THERE'S NOTHING LIKE good old American ingenuity to overcome problems. So, what's the issue here? Well, when building our rig, we noticed that once the motherboard and PSU were installed, the option to install a GPU in the top PCIe slot wasn't possible, as it conflicted with the PSU—it was too long to work with the standard ATX power supply. To get around this, we removed the PSU mounting bracket, then reinstalled half of it by ghetto-mounting it to the bottom of the chassis, running the passthrough cable underneath it, then mounting the PSU to the remainder of the bracket. Although it doesn't look pretty, it resolved an immediate problem. A long-term fix would be to use a Dremel to mount the piece to the chassis, then cut a section out to allow the PSU passthrough cable to sit comfortably.



2

HIGH-BANDWIDTH SLI BRIDGES

WE HAVEN'T HAD the opportunity to talk about Nvidia's latest high-bandwidth SLI bridge in the magazine yet, but we have to say, aside from looking spectacularly pretty, we've seen no noticeable difference in frame rate outside of margin for error, even at 4K. One thing this mighty pretty SLI bridge does do, however, is ensure that your GPUs don't have the structural integrity of a chocolate soufflé. Once you've got this installed, the two cards are rock solid, and in an inverted build like this one, that can be incredibly handy, especially if you're transporting your machine around. On the other hand, they're quite pricey to get hold of, add very little with regard to performance, and, considering this chassis is windowless, it may be worth leaving the bridge out in favor of spending the cash elsewhere.

GEFORCE
GEFORCE

3 AIO COOLERS AND MEMORY WOES

ALTHOUGH THE PHENOM'S SPEC page states that it supports a single 140mm fan in the rear, that doesn't mean a liquid cooler will fit. This is due to the radiator being bigger than the fan, particularly the reservoir that you can see below it. If you try to opt for a 140mm radiator, such as the NZXT Kraken X41 (our first choice), you're going to run into issues mounting it to the chassis. Then there's the fan conundrum; in this case, we opted to install it in a pull configuration, to maintain a positive pressure system, while also making it far easier to mount. It's also worth noting that we used low-profile memory—anything higher and you're going to struggle to install that rear I/O cooler. And if you're thinking of using an air tower, by blocking that airway by the 230mm intake fan, you'll end up stifling your GPUs.

4 EXTRA INTAKES

HERE'S ANOTHER PRIME EXAMPLE of an opportunity to get some modding in. What would be perfect here would be two additional 120mm fans running as intakes, blowing cool air on to the two GPUs. Unfortunately, with the vent off, it's just a touch too cramped to install two 120mm fans, because most are too deep to install with the dust filter as well. What you could do is either opt for two slim 120mm fans (Silverstone's Tek Professional Slims come to mind), or mod a new top fan cover with an extra half inch or so of height, to compensate for normal-sized fans. That way, you could drive even more air into the chassis, keep those two blower coolers well fed, and improve your overclocking headroom in the process.

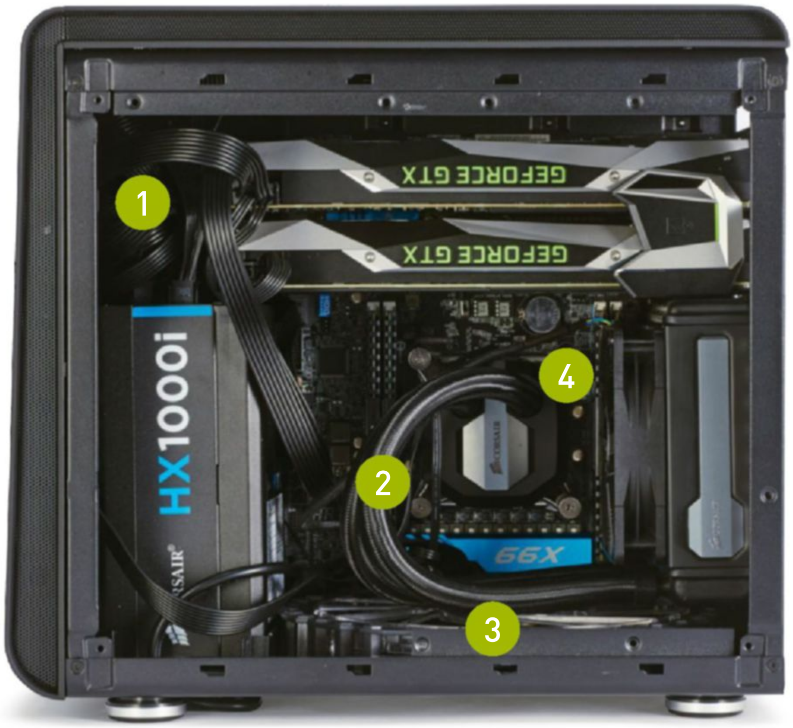
5 CABLE MANAGEMENT? WHAT'S THAT?

IF YOU'VE TAKEN A LOOK at that last image, you've probably decided we're really lazy, and couldn't be bothered to tidy up our cables. On the contrary—due to the orientation and positioning of the PSU in this chassis, there's very little room for us to move those cables around. It is possible to route some of the cables behind the motherboard tray through clever planning, but the vast majority of them need to sit on top of the PSU. Fortunately, it's not too much of an issue, because this is a windowless chassis, and as long as you're not blocking your 230mm intake fan on the bottom, all will be well in the world of thermals.

CORSAIR
HX1000i

6 SIDE PANEL I/O

BITFENIX HAS TAKEN an unusual route when it comes to the front I/O panel. Instead of embedding it on the top of the chassis, it's on the motherboard-facing side panel. The problem with this is that most of the front I/O connectors on motherboards are located just under the uppermost GPU, so in an SLI system, you'll have to plug the "front" panel I/O in before you install the final GPU. Fortunately, there is a way around this. If you take a look at the side panel, you'll notice the front I/O and HD audio are connected via a white plastic locking port—pull them out of the socket here, plug the connector ends into the headers on the motherboard, install your GPU, get your system all wrapped up, then plug them back into your side panel, and lock up shop. Job done.



1 This was one of the trickier builds to work in with regard to cable management. You might notice it becomes particularly cramped when installing both the 8-pin EPS power (see bottom-middle) and the 24-pin—an easy trick to unhook these is to use a key. Simply wedge it down from the top of the notch, press down, and pull the cable up and out.

2 There's going to be a fair amount of tension on that tubing when you're installing the AIO liquid cooler. But don't worry too much about it—Corsair assured us that the H80 is designed to take this level of strain, thanks to the cable braid that surrounds those water funnels.

3 The advantage of having a large fan like this is that it's exceptionally quiet, relatively speaking, certainly in contrast to 120mm or 140mm fans. Couple that with the insane amount of airflow it can draw in, and you're all set. Just remember to remove the solid dust filter located below before you install it.

4 What we would suggest if you are looking to build a 4K rig with two graphics cards, is that you opt for either a low-end X99 processor (the Intel Core i7-5820K or 6800K come to mind), or one of the latest Skylake processors.

4K GAMING ACHIEVED

THE IDEA was to build a system capable of gaming at 4K, that you could fit on your desk, and keep out of the way of pesky ungrown humans and furry animals. It's an admirable pursuit. Over the next two or three years, it's likely we'll see 4K gaming becoming more prevalent, certainly with the advent of DisplayPort 1.3 and 1.4, and 120Hz-plus monitors bounding toward us at breakneck speed. Hopefully, 60Hz panels will drop to 1080p levels—at least, that's the dream—enabling us to appreciate the glory of those high pixel density displays.

Did we achieve our goal? Sort of. Two GTX 1080s in SLI certainly make 4K gaming a reality, but it comes with its caveats. Power draw is the first issue. Even though Nvidia utilizes the 16nm FinFET process, the overall draw of both these cards is still significantly higher than the pinnacle of Maxwell, aka the GTX 980. Then there's the SLI profiles. Not all games support multiple GPUs, as it's mostly down to the devs to code that in, and even those that eventually do, most don't support it at launch. After all, the devs want to get their games out on time, and with the vast majority of gamers not taking advantage of two-way SLI or CrossFire, it's not a priority.

Then we have to deal with temperatures. Although we kept them within reasonable parameters (only three degrees higher than our recorded maximum on our test bed) with a tweak of the fan settings and some ingenious cooling layouts, it may not have worked as well with open-air-style coolers.

As for performance, this little beauty did admirably. At 4K, we saw an average of 71fps in *Far Cry Primal,* 64fps in *The Division,* and 35fps in *Rise of the Tomb Raider,* all on the absolute cutting edge of graphical settings at 4K. One thing to note, however, is that with SLI enabled, *Far Cry Primal* at 1080p scored 20fps less than with it disabled, proving once more that SLI is not perfect. In computational benchmarks, the Intel Core i7-6950X didn't disappoint, scoring an impressive 2,155 points in Cinebench, and 8,758 in PCMark 8 Creative.

Regarding the build process, there's no denying it was a nightmare. But that's always going to be the case with the vast majority of microATX and ITX systems. There's little room to move in such a small chassis, and cable management is a problem. In hindsight, it would have been much nicer to work inside the Corsair Carbide Air 240, as it is compartmentalized, which allows for cable management and better airflow. However, the Carbide Air 240 is relatively new, while the Phenom is less so, so hopefully, in the future, we'll see BitFenix produce something of a similar caliber, if not better. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	987	2155 (118%)
Cinebench R15 Single Thread	196	153 (-21%)
TechARP's x264 HD 5.0.1 (fps)	21.93	34.39 (57%)
PCMark 8 Creative	7,675	8,758 (14%)
Rise of the Tomb Raider	41	91 (122%)
Far Cry Primal	76	76 (0%)
The Division	78	148.4 (90%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM.
All games are tested at 1080p on max settings, with HD texture packages installed.

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RADEON
AMD
109-000947-00_02
RADEON

Simple, elegant, overly compensating cooler—what's not to love?

AMD Radeon RX 480 8GB

AMD smashes the budget market once more

SURELY, THIS IS THE YEAR of the graphics card? Think about it: We have the advent of VR, high refresh rate 1440p gaming, and not one but two die shrinks all occurring within the last 12 months. But let's face facts—it's all well and good having $650-plus graphics cards, but what really matters is making our platform more accessible. The more people who join the PC gaming community, the more investment comes in, and ultimately we all benefit. So, let's welcome AMD's first 14nm Polaris offering, the RX 480.

Aimed at the mid-range market, this $240 graphics card is designed to supplant Nvidia's GeForce GTX 970 from holding the title of value king. And, boy, does it do that with aplomb! With 36 compute units, 8GB of GDDR5 on a 256-bit memory bus, and drawing a meager 150W of power from the wall, you can expect the RX 480 to average around 5 TFLOPS of performance at stock. This places it quite nicely between the GTX 970 and the GTX 980 in terms of performance, and that's exactly what we saw. In Fire Strike, the RX 480 scored well over 1,000 more than its pricey competitor, with only the overclocked Gigabyte WindForce coming even slightly close to matching it. In game, we saw the RX 480 dominate 1080p, scoring average frame rates of 60fps and 58fps respectively in *Far Cry Primal* and *The Division*, with our more testing optimized titles, *Total War: Attila*, *Rise of the Tomb Raider*, and *Ashes of the Singularity*, scoring in the mid 30s.

The real trick here, however, is 1440p performance. *Far Cry Primal* happily reached 43fps on average, alongside *The Division*. Is that the ideal 60fps sweet spot? Well, no, but it's still 50 percent better than you'd get on a console, and on top of that, you have those 1440p HD textured graphics to enjoy, as well. For those less concerned about the competitive scene, and who just want a smooth-enough 1440p budget card, the RX 480 is ideal.

THE ELEPHANT IN THE ROOM

Let's talk about that power draw. There's been a smidgen of contention over this launch, particularly because the reference cards possibly draw too much power from the PCIe slot. This does appear to be the case, but it's worth noting that this card has been approved by the PCI-SIG organization, the body responsible for the PCIe specification. On top of that, the likelihood of destroying any modern-day motherboard (within the last five years, at least) is very slim. The only scenario you may encounter problems from overdraw is when utilizing multiples, and we're talking three or more here, at which point you'll start to see diminishing returns from your investments, anyway. So who does this affect? Overclockers and ASIC bitcoin miners. By the time you read this, it's very likely that AMD will have already released a driver to combat the concern, and aftermarket variants are available with far more advanced power solutions anyway. If you are concerned, though, we ran this card in Unigine's Heaven benchmark at 4K over a whole weekend, only to arrive back on Monday morning to see that the card was still functioning absolutely fine.

So, on to the overclocking experience. Amazingly, for a reference blower card, the RX 480 remained cool and silent, even under load. Although the fan can ramp up to higher volumes when upping those volts, in everyday general use and stock gaming, it's serenely quiet. We managed an overall overclock of 8 percent on the core, and +190MHz on the memory, enabling a final boost clock of 1,366MHz, and achieving a pretty pleasing 11,755 points in Fire Strike, even outstripping the GTX 980.

The question is, should you buy it? Well, as far as price-to-performance goes, the AMD Radeon RX 480 absolutely kills it. OK, it's not the processing powerhouse of a GTX 1080 or GTX 1070, but for value for money, this card is second to none. It's cool, quiet, efficient, and well worth it if you're looking to create yourself a VR-ready, 1080p frame-maxing goodie. – **ZAK STOREY**

VERDICT
9
KICK ASS!

AMD Radeon RX 480 8GB

+ URSA MAJOR Fantastic value; aggressively priced; strong 1080p performance; VR-ready; acceptable 1440p performance.

– URSA MINOR Power draw worries at launch; superior aftermarket cards.

$240, www.amd.com

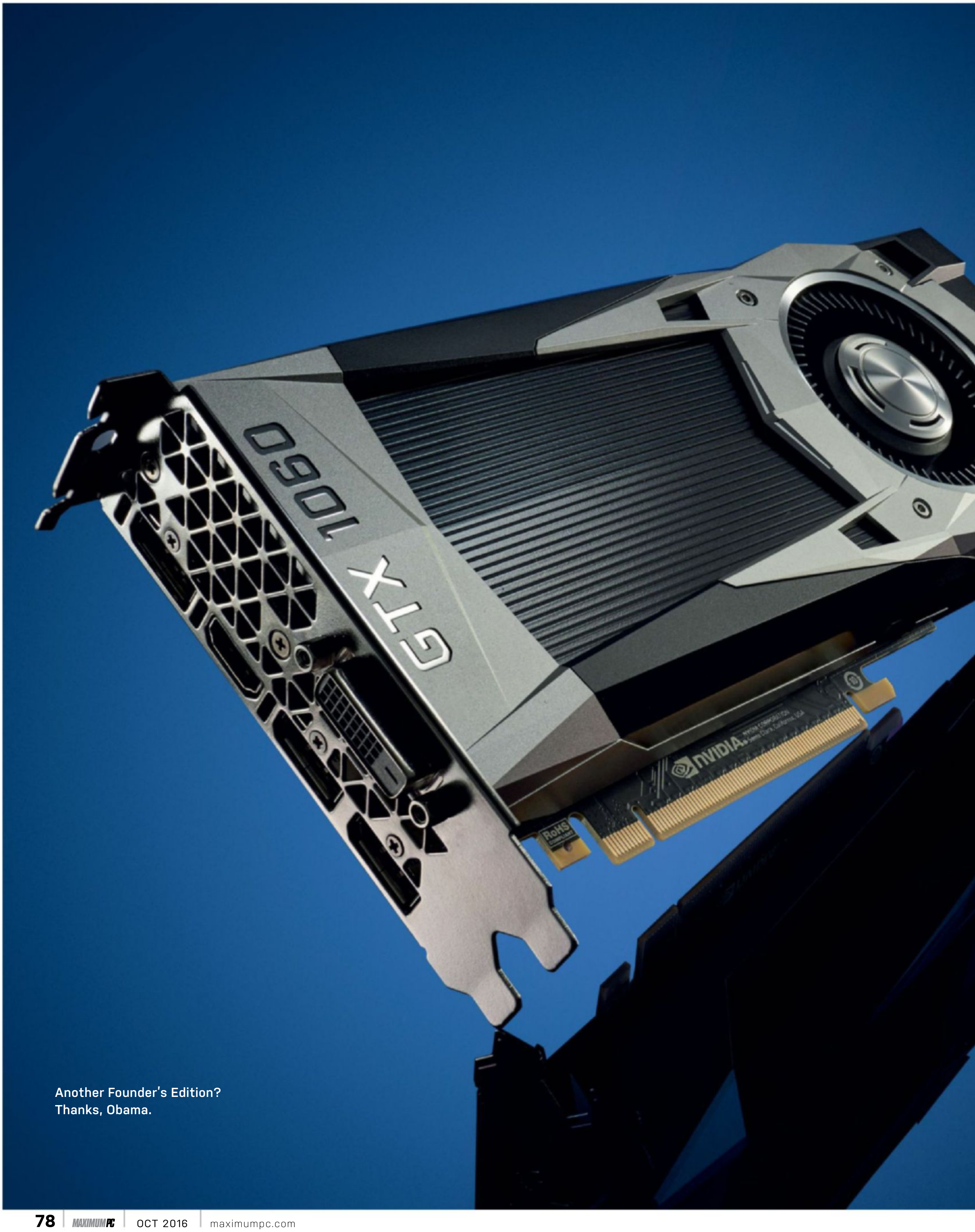
SPECIFICATIONS

GPU	Polaris
Lithography	14nm FinFET
Transistor Count	5.7 billion
Compute Units	36
Texture Units	144
ROPs	32
Core/Boost Clock	1,120MHz/1,266MHz
Memory Capacity and Type	8GB GDDR5
Memory Speed	8GHz
Memory Bus	256-bit
TDP	150W
Display	HDMI 2.0b, DisplayPort 1.3

BENCHMARKS

	AMD Radeon RX 480	Nvidia GeForce GTX 980	Nvidia GeForce GTX 970
Fire Strike @ 1080p	10,542	**11,338**	9,525
Fire Strike Extreme @ 1440p	5,205	**5,822**	4,915
Fire Strike Ultra @ 4K	2,725	**3,132**	2,545
Total War: Attila	21/30	**28/40**	21/32
Far Cry Primal	47/60	**51/65**	42/54
The Division	34/58	31/**62**	**37**/50
Rise of the Tomb Raider	11/34	**15/41**	10/36
Ashes of the Singularity	23/36	24/**38**	**26**/32

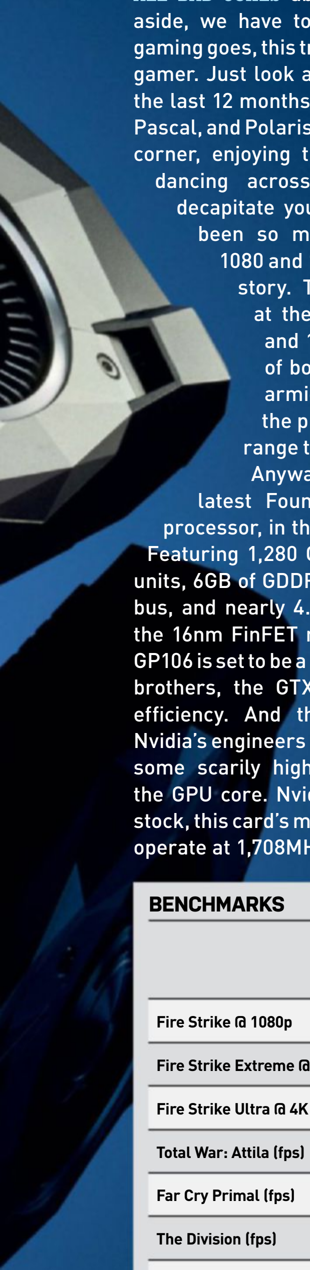
Best scores are in bold. Game results are minimum/average fps at 1080p. Our test bed consists of a Core i7-6700K, and 16GB of Kingston Savage DDR4 @ 2,400MT/s on an MSI Z170A Gaming M7 motherboard.


GTX 1060
NVIDIA
RoHS

Another Founder's Edition?
Thanks, Obama.

Nvidia GeForce GTX 1060

The fight for the value crown is on



ALL BAD JOKES about the online merger aside, we have to admit that, as far as gaming goes, this truly is the year to be a PC gamer. Just look at what we've seen over the last 12 months: Skylake, Broadwell-E, Pascal, and Polaris. And with Zen round the corner, enjoying those triple-A polygons dancing across the screen as you decapitate your latest foe has never been so much fun. But the GTX 1080 and 1070 only tell part of the story. The true battle will be at the mid-range: the 1080p and 1440p cards; the grunts of both graphics companies' armies. The flagships bring the prestige, but it's the mid-range that wins the war.

Anyway, here we have Nvidia's latest Founder's Edition graphics processor, in the form of the GTX 1060. Featuring 1,280 CUDA cores, 80 texture units, 6GB of GDDR5 at 8GB/s on a 192-bit bus, and nearly 4.4 billion transistors on the 16nm FinFET manufacturing process, GP106 is set to be a doozy. Like its Pascalian brothers, the GTX 1060 is designed for efficiency. And through that efficiency, Nvidia's engineers have managed to unlock some scarily high clock frequencies on the GPU core. Nvidia will tell you that, at stock, this card's maximum boost clock will operate at 1,708MHz, a full 530MHz higher than last generation's GTX 960. However, that's not entirely true. Thanks to GPU boost's natural overclocking tendencies, at stock our card fluctuated between 1,835 and 1,860MHz during testing.

At 1080p, performance is spectacular, clocking an average frame rate of 38fps in *Total War: Attila*, 66fps in *Far Cry Primal*, and 60fps in *The Division*, in contrast to the GeForce GTX 980, which scored 40, 65, and 59 respectively. So, this card certainly competes with its older generation's everyman's flagship. It's a similar story at 1440p, with the GTX 1060 scraping in wins or draws in all titles bar *Rise of the Tomb Raider*, due in part to that increased VRAM capacity, and new and improved 10-bit color compression, employed to ensure the 192-bit bus isn't a bottleneck.

CLOCKING UP

What's scary, though, isn't the stock performance, but what it can do once you delve into the overclocking settings. At the time of testing, overvolting control wasn't fully unlocked, but we almost didn't need it. Simply by ramping the power target up, and tweaking the GPU clock offset, we achieved an astronomical 2,151MHz on the boost clock, and an incredible 11,745 points in Fire Strike; 786 higher than at stock. With overvolting and more power-abundant aftermarket solutions, this card will be an incredibly entertaining overclocking experience, and no doubt will be pushing that 12,000-plus margin in Fire Strike well within the regions of an AMD Nano or GTX 980 OC edition. Coupled with the fact that it comes in at $300 for the Founder's Edition, and all of a sudden Nvidia is really keeping the ball rolling by tapping into the upper echelons of the mid-range market.

Is it better than the AMD Radeon RX 480 in terms of price to performance? Almost. GP106 has proven its might, and continues to show that Pascal is not an architecture to be taken for granted. Although the Founder's Edition still comes with a meaty price tag, and there's no opportunity to run SLI with this card later down the line, the GTX 1060 runs cool, it runs quiet, and it's more than capable of powering any 60fps AAA gaming experience at 1080p without a sweat. **–ZAK STOREY**

VERDICT
9

Nvidia GeForce GTX 1060

+ FOUNDING FATHER Stunning overclock headroom; GPU boost performance at stock; great 1080p/1440p card; cool and quiet.

− MUD FOUNDATIONS Pricey Founder's Edition; 3GB minimum VRAM on some models; no SLI.

$299, www.nvidia.com

BENCHMARKS

	Nvidia GeForce GTX 1060 Founder's Ed.	AMD Radeon RX 480	Nvidia GeForce GTX 980
Fire Strike @ 1080p	10,959	10,542	**11,338**
Fire Strike Extreme @ 1440p	**5,778**	5,205	5,366
Fire Strike Ultra @ 4K	**3,015**	2,725	2,808
Total War: Attila (fps)	**14/24**	13/19	**14**/23
Far Cry Primal (fps)	**38/45**	35/43	**38/45**
The Division (fps)	21/41	**27**/42	25/**43**
Rise of the Tomb Raider (fps)	**10**/23	8/22	8/**24**
Ashes of the Singularity (fps)	20/**30**	20/**30**	**26/30**

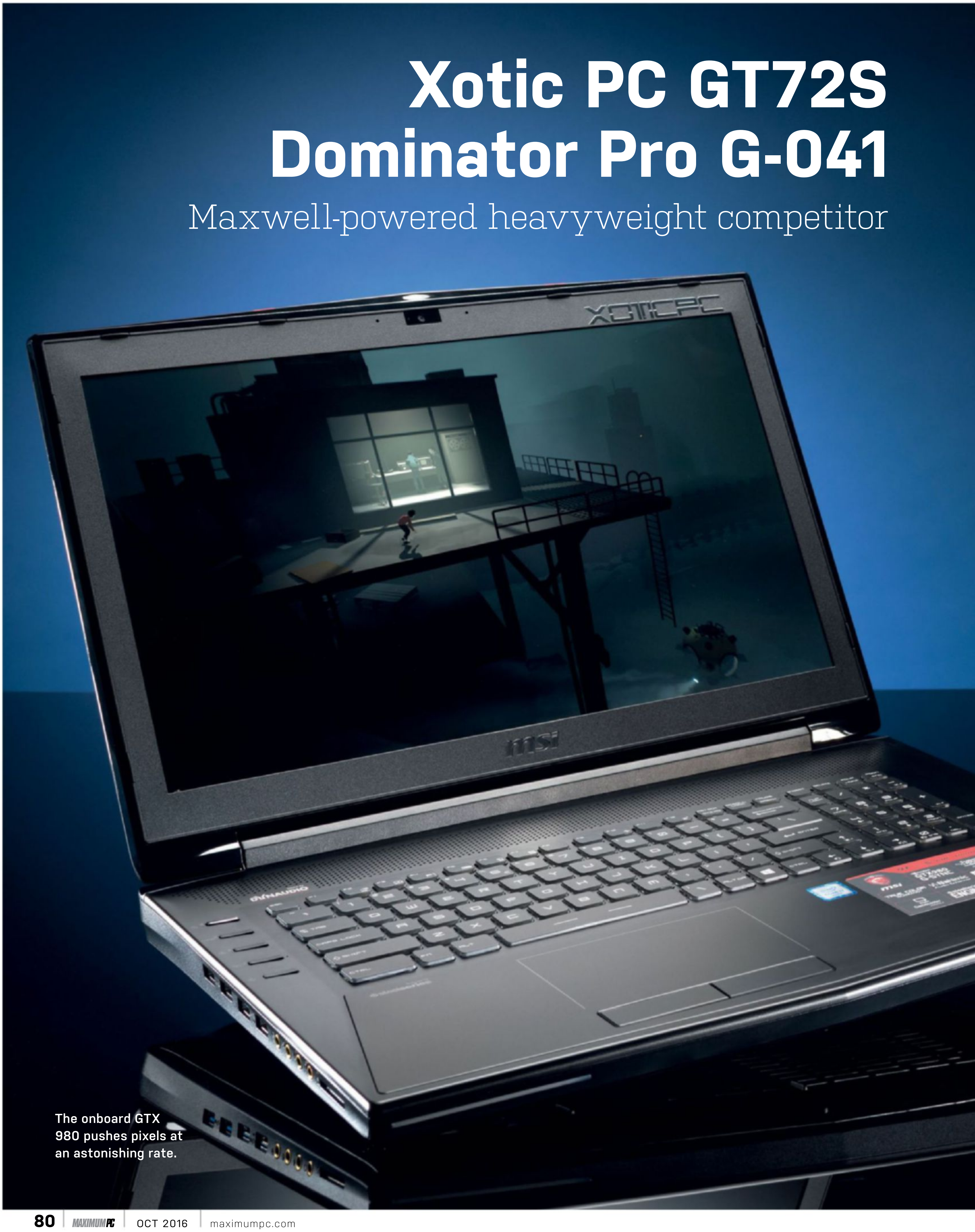
Best scores are in bold. Game results are minimum/average fps at 1440p. Our testbed consists of a Core i7-6700K, with 16GB of Kingston Savage DDR4 @ 2,400MT/s, on an MSI Z170A Gaming M7 motherboard.

SPECIFICATIONS

GPU	Pascal
Lithography	16nm FinFET
Transistor Count	4.4 billion
CUDA Cores	1,280
Texture Units	80
ROPs	48
Core/Boost Clock	1,506MHz/1,708MHz
Memory Capacity & Type	6GB GDDR5
Memory Speed	8GHz
Memory Bus	192-bit
TDP	120W
Display Connectors	DisplayPort 1.4, HDMI 2.0b, Dual Link-DVI

Xotic PC GT72S Dominator Pro G-041

Maxwell-powered heavyweight competitor



The onboard GTX 980 pushes pixels at an astonishing rate.

WHEN MOST PEOPLE think of a laptop, their mind usually goes to the same place: a lightweight, portable notebook that can fit, well, on their lap. Xotic PC's GT72S is indeed portable, and it is a notebook, but it's definitely not a laptop.

This is not a notebook that you'll see anyone try to bust out on a cramped coach seat on an airplane, or pull out of a trendy messenger bag after they lock up their fixed-gear bicycle. This thing is a heavy, portable gaming rig that's much closer to a desktop replacement than it is a laptop such as the Razer Blade 14.

The PC's innards are reason enough to set it apart from most other mobile computers. The PC is based on MSI's GT72S G-041, whose specs are mostly the same. The computer features a 3.8GHz Intel Core i7-6920HQ Skylake quad-core (with Hyper-Threading) CPU. That's just 200MHz slower than the (non-K) desktop i7-6700, and 200MHz faster than the i7-6920HK that was in the MSI GT72S 980 Dragon we reviewed late last year. Like the 980 Dragon, the GT72S G-041 carries an 8GB Nvidia GTX 980 onboard to push pixels. Note the lack of "M" in the nomenclature; this is a desktop GPU that's been put into a mobile PC. To top it off, the PC comes with 32GB of DDR4-2133 RAM, which is more than enough for most PCs, including desktops.

For connectivity, the PC features six USB 3.0 ports, one HDMI 1.4 port, a DisplayPort 1.2 connector, and one "Super Port." The Super Port is basically a USB 3.1 Type-C connector that is also compatible with Thunderbolt 3, which enables you to have mind-bendingly fast file transfers or a 10-gigabit Ethernet connection. The notebook uses Bigfoot Killer Ethernet and wireless adapters, which allow for the use of Killer's Doubleshot Pro networking features. (However, unless you've got two different Internet connections you can use at once, use cases for this technology are quite slim.)

One of the key hardware upgrades that comes with the Xotic PC model is the use of two Samsung 950 Pro NVMe SSDs, instead of the SM951s that come with the stock MSI model. Xotic PC also swaps out MSI's standard thermal compound with IC Diamond paste for the CPU and GPU. On top of that, Xotic PC shipped the PC with its "Redline Boost" GPU overclock and Windows optimization applied.

One thing we noticed was that the 17.3-inch IPS G-Sync display looked great during testing. The matte screen offered great detail and color with a reasonably wide viewing angle. It's a good companion for the powerful GPU, basically.

FRAMES AND FORTUNE

Speaking of testing, one thing that the GT72S does very well is play games. With the power of the GTX 980 behind it, the PC was able to push out pixels at an admirable rate. In *Tom Clancy's The Division*, the Xotic managed an average of 50.3fps at 1080p with ultra settings. The Xotic bested the Gigabyte P35X v5 by about 11fps. On the flip side, the Eurocom Sky X9 still outran the GT72S by 7fps in the same test. For comparison, the P35X is armed with a 3.5GHz i7-6700HQ and a GTX 980M, while the Sky wields a desktop i7-6700K and a GTX 980.

It's worth noting here that with the launch of Nvidia's Pascal line of GPUs, it won't be too long before we start seeing GTX 1060s, 1070s, and 1080s in laptops. Maxwell still has a lot of power, but the architecture's (and the 900 series's) days are numbered.

It was interesting to compare the Xotic's Core i7-6920HQ to the Core i7-6700HQ that is so common in other mobile gaming PCs. In just about every test, the i7-6920HQ has the edge. The Xotic beat the Acer Predator 15 by 65 points in Cinebench 15, and the Xotic pulled ahead in x264 too, although only by a little over 1fps. These wins, though sometimes small, can be attributed to the 6920HQ's 8MB of cache (compared to the 6700HQ's 6MB), and the fact that the 6920HQ has a 300MHz advantage.

Like we said at the outset, this PC is large. While some may be appalled at the size, the PC's thickness allows for an optical drive, a more robust cooling solution, and better audio acoustics. At 8.4 pounds, it isn't something you'd want to carry around in your hands. However, we were able to carry it in an MSI GT hardshell backpack for testing, which worked quite well. If you're planning on buying the GT72S, we recommend snapping up a good backpack, too.

At over $4,000 as configured, this PC is definitely an investment—you can build a formidable desktop PC for that amount, after all. But then again, you can't take your desktop as carry-on. **–ALEX CAMPBELL**

VERDICT
8

Xotic PC GT72S Dominator Pro G-041

+ EXOTIC DRAGON Powerful GPU and CPU; good sound; speedy storage and connectivity.

− EXTINCT DINOSAUR Heavy and bulky; Maxwell GPU will be obsoleted by Pascal.

$4,086, www.xoticpc.com

BENCHMARKS

	ZERO-POINT	
Cinebench 15	682	703 (3.1%)
x264 HD 5.0 (fps)	15.17	15.12 (-0.3%)
PCMark 8 Creative	6,180	7,267 (17.6%)
CrystalDiskMark 4K Read	44.2	542 (1,126%)
CrystalDiskMark 4K Write	162.1	437.7 (170%)
Far Cry Primal (fps)	37.2	59 (58.6%)
The Division (fps)	33.3	50.3 (51.1%)
Rise of the Tomb Raider (fps)	42.4	66.6 (57.1%)
3DMark Fire Strike	6.583	10,214 (55.2%)
Battery Life (minutes)	153	156 (2%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our laptop zero-point is the Asus G752VT-DH72, with an Intel i7-6700HQ, a 3GB GTX 970M, and 16GB of DDR4-2133. *Far Cry Primal* and *The Division* tested at Ultra settings at 1080p. *Rise of the Tomb Raider* tested at Very High settings with SMAA at 1080p.

SPECIFICATIONS

Processor	Intel Core i7-6920HQ
Graphics	GeForce GTX 980 8GB
RAM	32GB SODIMM DDR4 @ 2,133MT/s
Screen	17.3-inch 1920x1080 IPS G-Sync
Storage	2x 256GB Samsung 950 Pro M.2 NVMe
Battery	9-cell Li-ion
Networking	Killer Wireless-AC 802.11, Killer E2400 Ethernet
Connectivity	6x USB 3.0, 1x HDMI 1.4, 1x Thunderbolt 3/USB Type-C, 1x DP 1.2, Bluetooth 4.1, SDHC card slot, audio jacks
Dimensions	1.89 x 16.85 x 11.57 inches
Weight	8.4lb

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Intel Core i7-6800K

Six cores are better than four, right? Right?

INTEL® CORE™ i7
i7-6800K
SR2PD 3.40GHZ
J604C745 e4
769UD84281280

WE'VE ALREADY locked horns with the daddy of Intel's new family of uber CPUs, known as Broadwell-E. What a monster the Core i7-6950X is, all 10 cores and 20 threads of it. However, the 6950X is also a near-$1,600 slice of silicon. Value may be in the eye of the beholder, but that's silly.

In that context, the new Core i7-6800K looks intriguing. At just over $400, it's roughly a quarter the price of the 6950X. But with six cores and higher clocks, it's at least two-thirds the chip. It's also the latest entry-level model for Intel's big-iron X99 platform and the LGA2011-V3 socket. In many ways, then, the real comparison is with the Core i7-6700K on the mainstream LGA1150 socket, for around $100 less, plus savings on mobo and memory costs.

So, let's deal with the 6800K's speeds and feeds. Like the rest of the Broadwell-E crew, it's a 14nm chip, but not based on Skylake. Long story short: Since Intel split the desktop into two platforms, the high-end option has derived from server CPUs that lag mainstream desktop architecture by a generation. And so it is here.

However, for CPU features, that isn't much of an impediment. Along with 6 cores and 12 threads, running at 3.4GHz nominal and 3.8GHz Turbo, you get 28 PCIe 3.0 lanes and 15MB of cache. Factor in the quad-channel DDR4 memory interface, and there's no question that the LGA2011-V3 platform is a bandwidth monster with which the likes of Intel's mainstream CPUs and mobo chipsets cannot compete.

CORE STRENGTH

The question is, how much effect does all that have on real-world desktop usage? The answer is that it depends on what you're doing. In efficiently threaded software, like video encoding or professional graphics rendering, the six-core 6800K has the edge over its cheaper quad-core sibling. The gap isn't huge. The 6800K scores 1,099 in Cinebench, for instance, to the 6700K's 908. In x264 encoding, it's 23.85fps against 20.54fps. But the 6700K is a little higher clocked, offsetting those extra cores.

Elsewhere, it's a patchier story. The 6800K has a slight edge in the synthetic 3DMark Fire Strike benchmark, but it's neck and neck in *Rise of Tomb Raider*. Then in *Total War: Attila* it actually trails the 6700K's 55fps, at 52fps. When it comes to games, few titles scale well beyond four cores. Clock speed, in other words, counts.

Nor does the 6800K have a huge advantage when it comes to productivity metrics, including file compression or the PCMark 8 Creativity test. The 6800K also consumes significantly more power than the 6700K. However, when you factor in overclocking, the picture improves. With a maximum overclock of 4.5GHz, it doesn't reach the 4.8GHz heights of the 6700K, but it's starting with a 600MHz disadvantage in terms of peak Turbo speeds.

Which means the 6800K's proposition is finely balanced. As a gaming chip, it makes no sense. It's not a slam dunk as a pure high-performance desktop CPU, either. However, consider the platform advantages: memory bandwidth, PCIe connectivity, and an upgrade path all the way to 10 cores. Then add overclocking to the equation. Suddenly, the 6800K makes a lot of sense, even with the cost of an X99 mobo and quad-channel memory. It won't suit everyone, but for some it will be pretty much a perfect processor. **–JEREMY LAIRD**

BENCHMARKS

	Intel Core i7-6800K	Intel Core i7-6700K
Cinebench R15	**1,099**/127	908/**181**
TechARP's x264	**23.85fps**	20.54fps
Memory Bandwidth	**43.29GB/s**	28.76GB/s
5GB Compression	**132 seconds**	143 seconds
3DMark Fire Strike	**17,468**	17,016
Total War: Attila	52 fps	**55 fps**
Tomb Raider	**68 fps**	67 fps
Max Overclock Achieved	4.5GHz	**4.8GHz**
Cinebench R15 @ OC	**1,354**	1,048
Load Power	135W	**114W**

Best scores are in bold. Our testbed is comprised of 32GB (4x 8GB) Corsair Dominator Platinum @ 2,400MT/s, a GeForce GTX 1080, a 500GB Samsung 850 Evo, a Samsung 2TB SSD, and either an Asus X99 Strix Gaming or Asus Maximus VIII Formula motherboard.

VERDICT

8

Intel Core i7-6800K

+ **HIGH SCORE** Easy access to HEDT; good multithreading; strong overclocker.

− **BIT OF A BORE** Overall platform cost; mediocre single-core performance; games struggle to compete.

$435, www.intel.com

SPECIFICATIONS

Base/Turbo Clock	3.4GHz/3.8GHz
Cores/Threads	6/12
Lithography	14nm
Cache	L3 15MB
Memory Support	128GB DDR4
Memory Channels	4
Max PCIe Lanes	28
TDP	140W

Philips 276E6ADSS

More colors for less cash, the quantum physics way

REGULAR *MAXIMUM PC* readers will be familiar with the nanoscale effect known as quantum confinement. It's the one that involves electron holes, two-dimensional potential wells, and the exciton Bohr radius. Right?

If we've lost you, don't worry. We're not going to pretend we fully understand the high-brow physics that powers quantum dot technology, either. But that's OK, because the implications of quantum dot tech are actually pretty simple. Imagine tiny specs of material that absorb light, convert it to a different frequency, then re-emit it, and you'll have a decent idea of how it works.

The upside in the context of screens is also pretty straightforward. It means you can use a cheap, monotone LED backlight, instead of the pricey RGB alternative, and still achieve a really broad spectrum of colors. In theory, with the right number, size, and composition of quantum dots modifying the output of the backlight, the net result will be a wide-gamut monitor for relatively low cost.

Enter the Philips 276E6. While quantum dot tech has rolled out across the HDTV market fairly quickly, this is one of the first such screens in the PC monitor space. For a mere $300, you get a 27-inch monitor with an IPS panel, which isn't a bad start. Thanks to that quantum dot stuff, the Philips also packs full support for the Adobe RGB color space, a feature normally reserved for pricey pro monitors.

Other highlights from the spec list include support for the MHL display interface, along with HDMI, DVI, and VGA inputs. The OSD reveals a few worthwhile frills, too, including a triple-level pixel overdrive option for speeding up panel response. For the record, pixel response is rated at 5ms. Beyond all that, however, it's not hard to see where corners were cut, and how that price was achieved. There's no fancy 100Hz-plus refresh, and no support for any kind of adaptive synching technology, for instance, and the stand lacks any adjustments other than tilt.

PALTRY PIXELS

Of course, adaptive sync is a gaming-centric technology that's arguably irrelevant with a screen designed to shake up the wide-gamut segment. But high refresh is always nice to have. In any case, the biggest catch is actually the modest 1920x1080 pixel grid. That really is pretty stingy for a 27-inch panel, where 2560x1440 makes for a tighter pixel pitch, sharper images, and more desktop real estate.

Anyway, that's the speeds and feeds dealt with. Does the Philips and its funky quantum dot tech deliver? In a word, sometimes. Initial impressions are disappointing. The inherent quality of the 276E6's IPS panel isn't all that spectacular, in part due to the lack of outright pixel density. In this age of near ubiquitous "retina"-style displays in mobile devices, the 27-inch Philips, with its 1080p resolution, looks distinctly grainy.

The outright brightness of the backlight is nothing special, either, and the white tones aren't as clean and vibrant as you might expect, given the exotic backlight enhancements—something that isn't helped by a fairly coarse anti-glare coating. Then there are the colors. Here, the 276E6 finally begins to comes good. There's an undeniable uptick in saturation and vibrancy compared to a conventional panel.

Unfortunately, the factory calibration is distinctly overbearing in the red channel, which most notably distorts flesh tones in video and images. Some of this can be dialed out with calibration, but we couldn't achieve entirely satisfactory results. Combine that with the limited pixel pitch, and the harsh truth is that it's hard to see who this monitor would suit.

It's not a bad gaming panel, but nor is it optimized for games. It does technically offer a broader color space for graphics, video, and image work, but it's poorly calibrated out of the box, and we have our doubts regarding its outright accuracy. And then there's that 1080p pixel grid—hardly a boon for productivity. It's an interesting early look at quantum dot technology, for sure, but it's simply not a compelling purchase. **–JEREMY LAIRD**

VERDICT

7

Philips 276E6ADSS

⊕ **QUANTUM LEAP** Clever tech increases color depth for cheap; decent all-round image quality.

⊖ **JUST CHEAP** Poor color calibration; modest native resolution; limited features.

$300, www.philips.com

SPECIFICATIONS

Panel Size	27-inch
Native Resolution	1920x1080
Panel Type	IPS, 8-bit quantum dot
Maximum Refresh	60Hz
Response	5ms
Contrast Ratio	1000:1
Display Inputs	VGA, DVI-D, MHL-HDMI
Connectivity	None
VESA Mount	None
Warranty	Two years

Nice try, Philips, but who is this screen aimed at?

Corsair ML140 PRO LED Fan

Magnetic levitation, you say?

FANS ARE TRICKY. To most people, as long as they spin and keep air flowing, they mean very little. To others, they're a statement. They're about gaining every inch of ground possible in the cooling or silence battle. They're about accenting your build, adding an element of movement in an otherwise lifeless and solid-state system. And we've come a long way in the last 10 years—from air towers and 82mm fans spinning at 3,000rpm, to super-quiet, specialized fan blades designed to spin at lower and lower revolutions per minute, while still pumping out the same amount of air and pressure.

Alongside Noctua, Corsair has been at the forefront of cooling technology for some time. Although often slightly behind the legendary Noctua NF-F12 in terms of overall performance, it's hard to deny how popular Corsair's line of SP series fans is. But the battle for noise control is ongoing, and as enthusiasts who favor water cooling and other specialist pursuits hunt for ever-quieter fans, something has to give. After all, although the SP120 performed admirably in contrast to its beige brothers, it just couldn't compete when it came to noise versus performance. Take the SP120 versus the NF-F12. On a full 12V, the high static pressure edition could pump out an impressive 3.1mmH$_2$O at 35dBA and 2,350rpm. Compare that to Noctua's NF-F12, and it's 3.94mmH$_2$O at 29.7dBA and 2,000rpm. A sizable difference—but, at twice the cost, that's what you would expect from the less colorful competitor.

WHO NEEDS BALL BEARINGS?

Corsair's response was to work on the motor itself. Instead of using a traditional three-phase, ball-bearing design, the engineers have developed, in secret, a master motor. It uses a technology that, for trademark purposes, we've been informed we can't call maglev, but, in reality, it's maglev. Or magnetic levitation. In short, by applying enough voltage to an electro magnet, it's possible to make the motor levitate and spin the fan blades without touching the motor housing at all, or relying on lubricant or a ball bearing to create that motion. In theory, this should reduce noise and improve the fan's lifetime, as there's little friction involved, apart from a fractional amount of air resistance.

The biggest advantage over the previous SP series comes down to how slowly these magnetically levitating fans can spin. In our testing, we found that to be around 387rpm. That's 600rpm slower than some of the leading brands. Why is it so important? Think of it this way: you're not rendering, gaming, or 3D modeling 100 percent of the time—we spend an astronomical amount of time just sitting on the desktop or browsing the web. During those periods, you don't need your fans to be spinning at full bore, trying to move heat out of your chassis. And if they are spinning that rapidly, it can be distracting. One solution is to use a dedicated fan controller to switch off your fans. However, when your CPU does start to heat up a fraction, you may notice that, for your fans to switch on properly, your controller pulses them back into action, usually resulting in a 1,400rpm quick burst, before they settle down to their preset speed. So, by having fans that spin so slowly, you can maintain a constant speed and cooling, at levels that are almost inaudible to the human ear.

As far as cooling goes, you're not likely to see much difference between any of the static pressure optimized fans. However, for those looking for a silent PC operating environment, both when gaming and when delving around in the depths of the Internet, Corsair's new ML PRO series fans are exceptional. Pricey? Yes. Quiet? Damn straight. –ZAK STOREY

VERDICT
9
KICK ASS!

Corsair ML140 PRO LED Fan

+ **RAIL GUN** Insanely low RPM; LED variants; intuitive design; impressive performance.

− **FRIDGE MAGNET** Price.

$35, www.corsair.com

BENCHMARKS

	Corsair ML140 PRO LED Fan	NZXT Kraken X41 Stock Fan
Lowest Operating RPM	**387**	785
Maximum Operating RPM	**2,000**	**2,000**
Maximum dB	**37**	**37**
Max Load Temperature @ Stock on Curve	**53**	55
Max Load Temperature @ Overclock on Curve	83	**82**
Max Load Temperature @ Overclock at Max	**71**	74

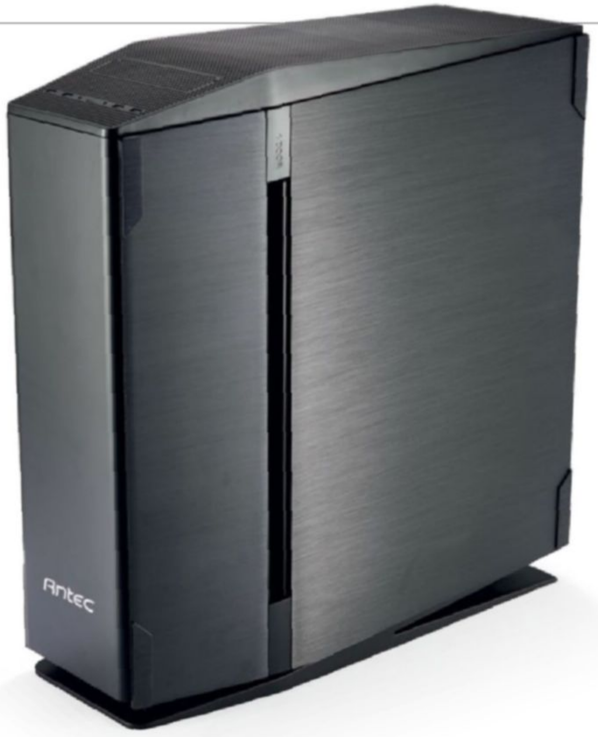
Best scores are in bold. All temperature tests used HWMonitor and OCCT for five minutes. Test bench comprised an Intel Core i7-6700K, NZXT Kraken X41, and an MSI Z170A Gaming M7 mobo. Overclock is 4.8GHz @ 1.4V.

SPECIFICATIONS

Dimensions	140 x 140 x 25mm
Connector Type	4-pin PWM
Rated Airflow	97 CFM
Rated Static Pressure	3.0mmH$_2$O
Rated RPM	400–2,000
Fan Noise	16–37dB(A)
LEDs	Yes

Antec Signature Series S10

We've been spoilt for far too long



WE'VE REACHED a precipice. An icy clifftop, upon which we all now teeter, clutching at tiny handholds as the heat of the sun cracks the delicate lattice of ice crystals holding it all together. Chassis manufacturers have pushed us toward it, with modularity-embedded metallic cuboids, bespoke custom designs, removable motherboard trays, wireless Qi chargers, curved steel panels, and a whole plethora of other intuitive innovations. At this point, we have to ask, is there room for such a thing as a poorly built chassis in today's enthusiast scene? Is it possible to head back into the icy depths of chassis peculiarity?

Antec's Signature Series S10 is a $400 behemoth. It lands slap bang in the middle of big sky country, as far as chassis manufacturers are concerned. The glinting aluminum greets you boldly as you unbox this towering colossus from its over-engineered hard-foam packaging. There's strength here—the 3mm thick metallic alloy exudes it; the hinges, less so. Two of the four side panels were detached by the time they arrived at our office. That said, once you do suss out how they attach to the frame, it's a solidly built full tower. Amazingly so, in fact. The vast bulk of this leviathan weighs just a little under 40 pounds, which is impressive when you consider how much of the aesthetics are marred by plastic polymer substitutes.

So, let's talk internals. The S10 is split into three separate compartments. You have the main motherboard segment, which is finished with a floor panel, creating a separate PSU and 2.5-inch drive segment, then a specialized separate compartment specifically developed for hard drives at the front. This is by far the most interesting addition, and also one of the greatest points of contention. For artistic design, this part of the chassis is entirely segmented from the main bulk, attached only briefly by passthrough points at the top and the bottom of the robust sub-tower. What this does, other than look glamorous, is allow cool air to pass in between and be drawn into the main motherboard compartment, through the triple 120mm fans lining the interior of the motherboard compartment. However, if you plan on populating the bow of this mighty vessel with hard drives, you may want to invest in some longer SATA power extensions cables—although the S10 comes with a few, they may not be enough for what you have in mind.

FAN CLUB

Cooling in the main chassis is provided by up to three 120mm fans in the front, two 140mm fans in the roof, and one 120mm fan in the rear. On top of that, you also have the option to include a 120mm fan in the PSU chamber, and one in the hard drive chamber, located at the front of the chassis. Although it sounds like a lot, those thinking of a full custom loop might be disappointed, because space is tight in the main compartment once fans are installed. It all goes back to the concept of height over width. Although the case is quite tall, that lack of internal capacity doesn't allow for any thicker rads to be installed in that front intake.

So, who is this for? In our eyes, it appears this chassis was built for those looking to build an air-cooled AIO X99 E-ATX rig. Someone not wanting much in the way of aesthetic looks, or interior chilling flare through liquid-cooling solutions, but rather a low-maintenance, power build instead. But that in itself brings up a problem, notably the price. It's $400, and when you consider you can get yourself a Phanteks Enthoo Primo for almost $150 less, or even a custom Case Labs Merlin SM8 for $70 more, both of which are vastly superior in overall construction and material use, we have to question Antec's decision to list this case at such a high price point. **–ZAK STOREY**

VERDICT 6

Antec Signature Series S10

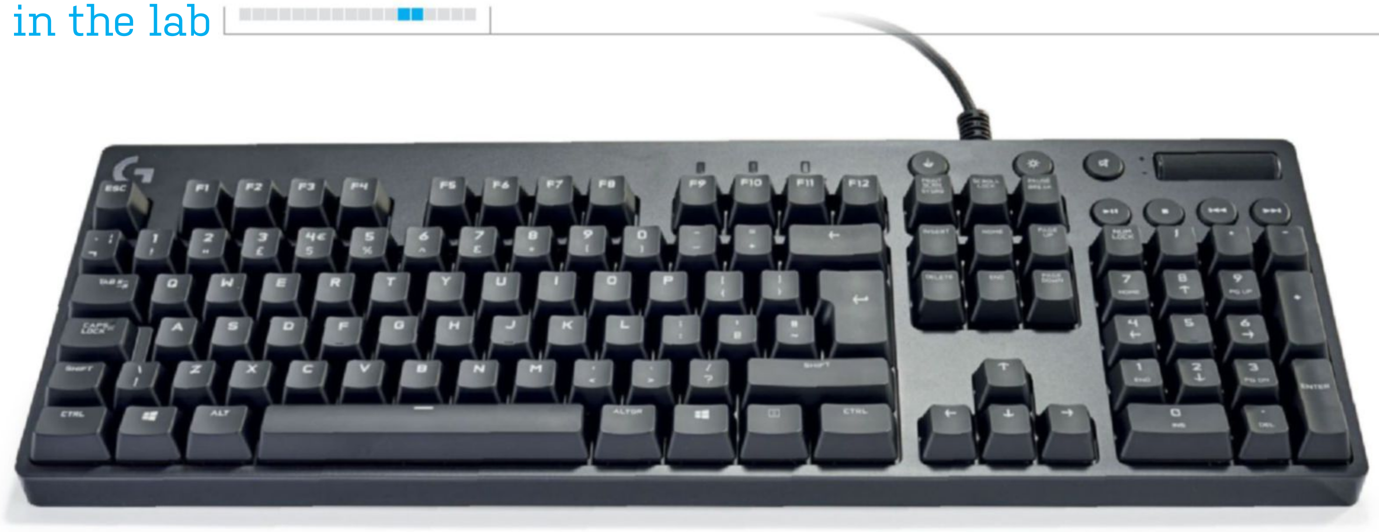
+ SIGN UP Aluminum panels; innovative hard drive cage; good airflow; easy to build in.

− SIGN OFF Too much plastic; flimsy hinges; price; limited liquid-cooling support; price; overall footprint; did we mention price?

$400, www.antec.com

SPECIFICATIONS

Form Factor	Full tower
Motherboard Support	E-ATX, XL-ATX, ATX, microATX, Mini-ITX
Colors Available	Black
Window Available	Yes
5.25-Inch Support	None
3.5-Inch Support	x6
2.5-Inch Support	x8
Radiator Support	280mm roof, 360mm front, 120mm rear
Fan Support	3x 120mm front, 2x 140mm roof, 1x 120mm rear
Dimensions	23.7 x 9.5 x 23.2 inches
Graphics Card Clearance	13.5 inches
Weight	39lb



Logitech G610 Orion Brown

The keyboardiest keyboard you'll ever keyboard on?

ORION BROWN is surely the alter ego of some DC superhero. Armed with a minimal set of powers and, inevitably, a skin-tight black catsuit, Cherry Girl fights crime in a city overrun by gigantic metal monsters capable of firing colored lasers everywhere they go.

Tortuous metaphors aside, what Logitech has produced here is a... keyboard. It's black and rectangular, the keys sit on a choice of Cherry MX Red or Brown switches (ours has Browns, hence the name), rather than the home-made Romer Gs seen elsewhere in the range, and there's a couple of media keys at the top-right. This positions it squarely in the all-rounder bracket—the MX Brown switches having a click that gives feedback for gamers, as well as being perfectly comfortable to type on. Even enjoyable, because each letter clacks into place, and you can find yourself trying for longer and longer runs of uninterrupted strokes, just to hear and feel the mechanical movement beneath your fingertips.

The G610 Orion Brown is solidly built, without a hint of flex, in a gleaming black exterior that's more or less identical to the G810 Orion Spectrum (RGB lighting, Romer G switches, $30 more). It's plastic, though, and the keyboard's footprint is on the small side in a market that's seeing wider and deeper models, with more exposed metal, released every month.

You don't get any built-in wrist support, which is a good choice, because that sort of thing is highly subjective, and best left to the user to arrange. Four soft rubber pads prevent it from sliding around on your desk, and two small feet can jack the back up in three stages if you want more of a slope, undoing the work of the pads somewhat in the process.

The top-right is the home of the media keys and, as with the G810, these are a disappointment. We can see the rationale behind not sitting them on mechanical switches, but when every other key slides like a greased stripper, a tinny membrane switch is going to look like an afterthought. It's nice to have them, though; the volume roller is wide enough for precise adjustments, and the Game Mode key—which disables the dastardly Windows key, so you don't pop the Start menu up by mistake—is a godsend for the clumsy.

LIGHT INDUSTRY

There are no additional programmable macro keys, but the F keys can be assigned functions using the reliable Logitech Gaming Software—we guess they couldn't come up with a name for it, having wasted all their creative effort on the hardware names. The software also controls the lighting, which comes in any color you like, as long as it's white. This is all you need in a keyboard—enough to see it in dim conditions, and able to be customized in conjunction with that Game Mode button, to highlight WASD when you switch from Excel to *Doom*. You can make waves ripple across the board, or keys light up when you strike them, but these are novelty acts that you might use once, then never touch again—much like the Logitech Gaming Software itself. Once it's set up, this is a keyboard you'll rarely tinker with.

Without RGB lighting, USB passthrough, or headphone ports, there's an admirable purity about the G610. It's not pretending to be anything it's not, and its functions are pared back to only the most useful. The 26-key rollover is enough for you to get all fingers and toes on it without a problem, the 50-million-keystroke lifespan of the switches means it'll last, and the slender footprint makes it a convenient companion for a cluttered desk.

Logitech has made some great products recently, its gaming mice especially leading the field in terms of features and usability. This keyboard, and those above it in the range, show that the Swiss firm is capable of restraint, too. –**IAN EVENDEN**

VERDICT 8

Logitech G610 Orion Brown

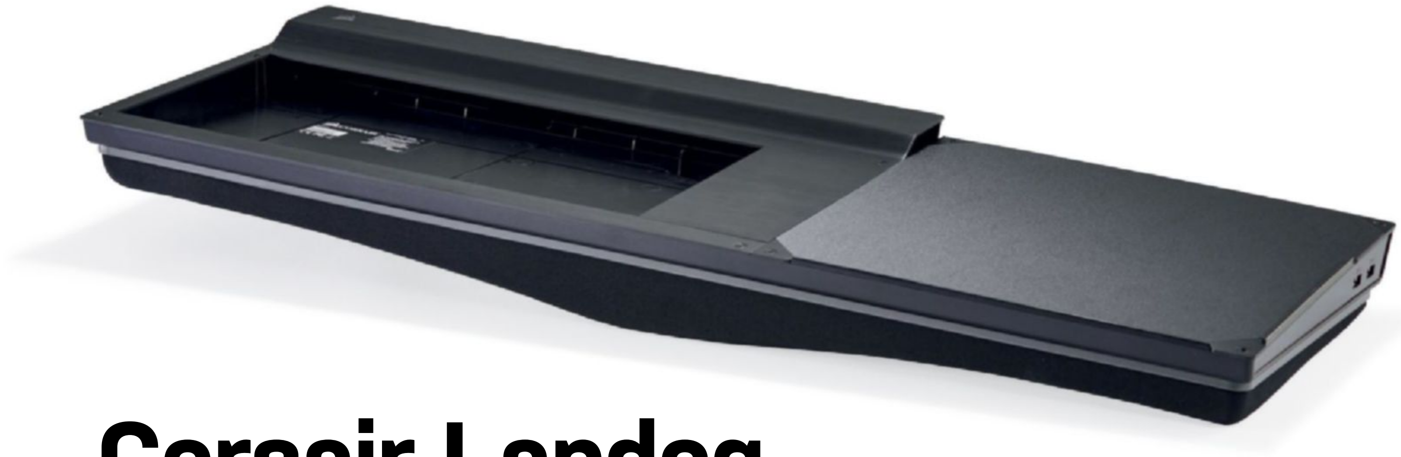
RESTRAINED Does what you want without superfluous fluff.

CONSTRAINED No Blue or Black switches; could be cheaper.

$100, www.logitech.com

SPECIFICATIONS

Switch Type	Cherry MX Brown/Red
Form Factor	Standard
Media Keys	Dedicated
Macro Keys	None
LEDs	White
N-Key Rollover	26
Passthrough	None
Dimensions	17.5 x 6.0 x 1.4 inches
Warranty	Two years



Corsair Lapdog

Is this the answer for lazy living-room gaming?

WITH THE ADVENT of SteamOS and living-room PC gaming, it was inevitable that we'd see the rise of a variety of gaming peripherals developed to enhance your couchmaster gaming experience. Whether that's Corsair's Lapdog, Razer's Turret, or Roccat's Sova, we're well served by gaming gear designed to transfer the accuracy and versatility of signature peripherals into the world of the big-screen TV.

Corsair's meticulously designed Lapdog is a highly advanced form of locking tray. The overall style follows the now-legendary K70 aesthetic: Thick, brushed aluminum panels litter the frame, giving the Lapdog a premium feel. The mouse mat is a reinforced hard plastic, mimicking Corsair's MM400 gaming surface, yet it's still just a cover hiding yet another aluminum plate below it. The Lapdog sits on a memory foam-formed cushion, specially designed to fit around your legs, and lined with relatively powerful magnets, ensuring that the tray doesn't slip off during even the most intense of nerd rages.

Installing your hardware into the Lapdog is relatively painless. You should note that the Lapdog only supports the K70 or K65 compact mechanical keyboards—no Strafe support or K95 here. All in all, it's just a matter of removing the screws holding the various plates down, slotting your mouse cable into the internal USB hub located underneath the mouse mat, then slotting in your chosen K70 to do the same. Then it's simply a case of locking everything down, plugging in the cable, and you're good to go. It's worth noting that the Lapdog does come with an additional power brick that you can plug in, but in our testing, utilizing a single mouse and keyboard, there really was no need.

PUPPY DOG

As for using the Lapdog, it's a mixed bag. It's comfortable, it looks sleek and classy, and the mouse mat provides great traction, even if it lacks some of the magnetic capabilities of its competitors. Our biggest problem is with typing—unless you're just using WASD, you have two options: you contort your body to some new demonic position to allow yourself the freedom to type at a reasonable speed; or you can shuffle the Lapdog along, rest the middle crotch lock cushion on the opposing side of your right leg, then type as usual, with a more centralized keyboard. The keyboard is too far to the left to be a natural position for typing. It's acceptable for gaming, but a more central keyboard, like on a normal desktop, would have made this far easier to use. We understand why this decision was made—for the sake of balance—and the fact that you should be typing less and gaming more, but it seems like a missed opportunity. Adding extra length on the left with, say, a cup holder to retain balance, and recentering the keyboard, would have made a world of difference.

Then there's the aluminum. It looks spectacular, but there's one problem: those sharp lines. It's all good until you realize how much the Lapdog can cut into the palms of your hands if you sit at the wrong angle. There's no wrist rest included, and in our experience, it became quite uncomfortable after lengthy gaming sessions. Couple that with zero options when it comes to raising the angle of your K70 or K65 keyboard, and we just felt a little underwhelmed. It's not razor sharp, but it leaves a mark on your skin. Another easy solution would have been to extend the Lapdog again, just a little further toward the user, to ensure your hands weren't resting on the edge of the aluminum.

So, it looks classy, it's comprised of premium materials, and is easy to set up. Does it make gaming in the living room a reality? Absolutely—but there are too many niggles for us to let it off lightly. It's nearly ready, but we feel Corsair just needs to take a step back, re-evaluate some of the criticisms, and come back with a V2 of this beauty before we ditch our desktops for the luxury of couch gaming. **–ZAK STOREY**

VERDICT 6

Corsair Lapdog

➕ **HELL HOUND** Beautiful aesthetics; well constructed; easy to set up.

➖ **CHIHUAHUA** Price; edges; no angle adjustment; no easy typing solution; limited compatibility.

$120, www.corsair.com

SPECIFICATIONS

Dimensions	29 x 10 x 3 inches
Keyboard Compatibility	Corsair K70 and K65
Mouse Pad Area	11 x 10 inches
USB 3.0 Hub	2 internal, 2 external, power available
Cable Length	17 feet

Boss battles against badass beasties are home to much of the game's imagination.

The Technomancer

Spiders from Mars lack Stardust

SHOCKINGLY, near-future Mars turns out to be not a great place to live. Not only have the corporations assumed the roles of states, and are fighting over water and resources (and if that's not foreshadowing, we don't know what is), but everybody has their face frozen in such a way that only their mouth can move.

Spiders, French developer of *Mars: War Logs* back in 2013, and 2014's *Bound By Flame,* has woven a new sci-fi RPG using a modified version of Sony's popular free-to-use PhyreEngine. Technically, it's more of a hit than a miss, as the sharp output brings a brutalist art style to the fore, even if it is all rather brown. Huge halls extend into the distance without blurring, while the details of crossed hammer carvings and paintings of contented workers aren't marred by post-processing. It sounds like we're praising the game for being a bit old-fashioned, and in a way we are—because everything is so sharp and clear, the choice of design motifs makes perfect sense.

There's a downside, though. To go along with those frozen faces, the game's characters have skin like a squash. The face we chose in the limited character creator had scars on its cheek, and we got to see every clearly-defined nuance of them as the game progressed. Soft-focus photography was invented to flatter those who didn't want to see their imperfections. Someone needs to invent the soft-focus dialog scene.

Once you're out in the world, there's a lot of depth to be found. Everything has a system attached to it, with several upgrade trees, experience points, weapon/armor modifications, and a party system. Those who like to obsess over the implications of every point they spend will be in heaven, assuming heaven has other, less frustrating games to play when you need a break. The main annoyance comes from the combat. Fighting is hard on Mars, with every street gang seemingly capable of taking your character down.

This is unexpected because, as the name of the game suggests, you are a Technomancer—essentially, one of Mass Effect's Biotics. You've got implants that enable you to channel electricity into your weapons, or send it arcing across the battlefield, and even though you're newly qualified at the start of the game, you've still been receiving training for a while. The combat is real-time, button-mashy (using a controller is recommended), and a bit repetitive. You choose from three stances, lock on if you choose, then wade in with two attacks, plus magic powers, a dodge button at the ready to acrobatically move you out of danger. So, the fact that you end up on the floor so many times grates.

Spiders' homage to BioWare isn't actually bad—in fact, it's great to see this level of assurance from an indie developer, and as we wait for *Mass Effect: Andromeda,* it may be the sci-fi fix you're looking for. But, if it's an RPG you're after, there are many games on the market with better mechanics and better stories. **–IAN EVENDEN**

VERDICT 5

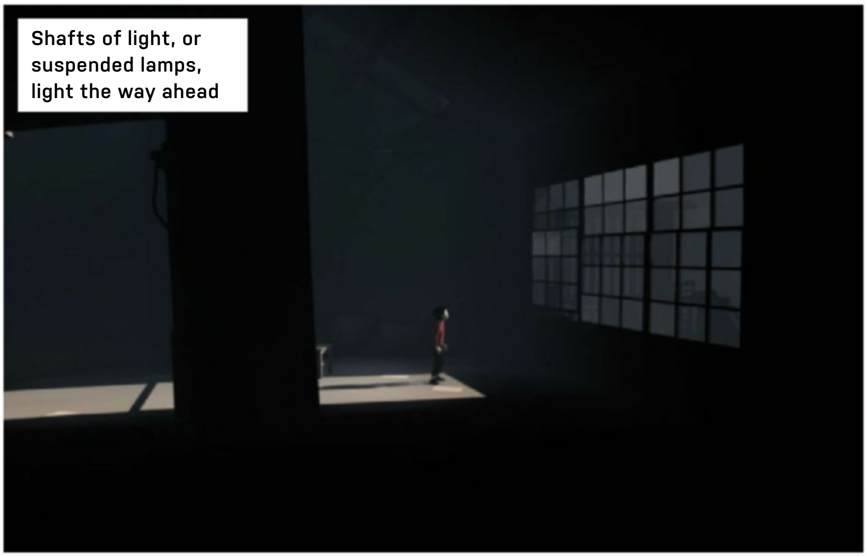
The Technomancer

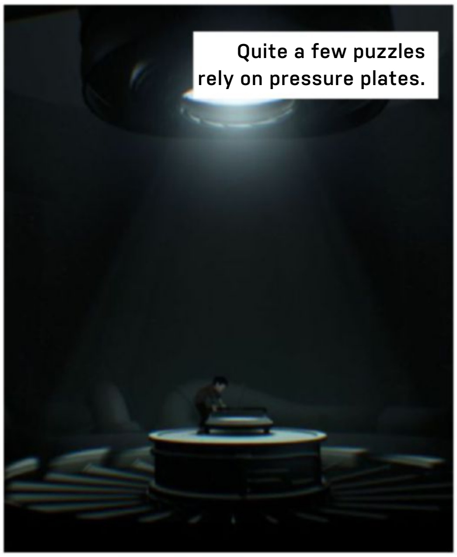
+ TECHNO Sharp graphics; plenty of depth and content.

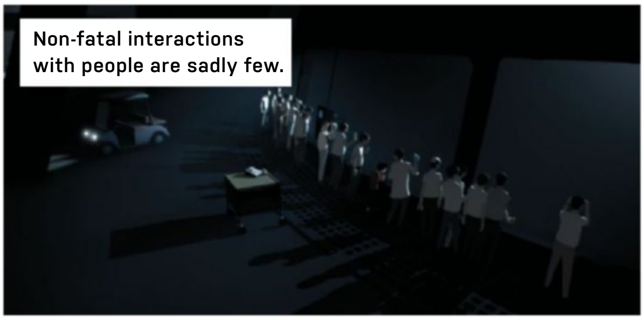
− HECK NO Frustrating combat; dull dialog; very slow start.

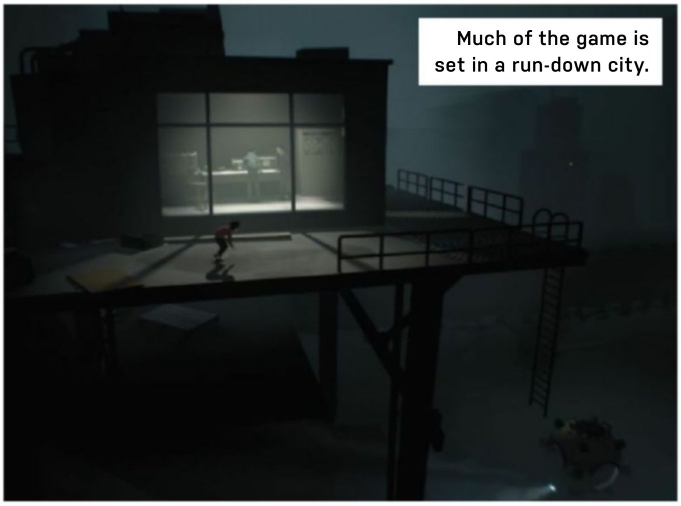
RECOMMENDED SPECS Core i7-2600 3.4GHz or AMD FX-8350; GeForce GTX 950 2GB or Radeon HD 7870 XT; 8GB RAM.

$45, www.thetechnomancer-game.com, ESRB: M


Shafts of light, or suspended lamps, light the way ahead


Quite a few puzzles rely on pressure plates.


Non-fatal interactions with people are sadly few.


Much of the game is set in a run-down city.

Inside

It's got the right stuff

TRUST US, you don't want this spoiled for you. It would be easy to reveal *Inside's* story by accident, and we agonized about the images that accompany this review because we didn't want to give anything away. *Inside* isn't long, and it's not particularly complex, but this boy's journey is best enjoyed cold.

Swedish indie developer Playdead made a game before—you might remember it. *Limbo* saw a silhouetted boy travel through a dangerous monochrome forest, and *Inside* channels a great deal of that game. The 2.5D art style is what immediately strikes you, all muted colors, creepy shadows, and shafts of light. The lack of faces on any character makes the boy you control a suitably empty vessel to empathize with, while on everything else it becomes a horror film trope to provoke a reaction of unease.

And uneasy you should be. The boy is fragile, and can be taken down by one shot, one bite, one underwater grab. You don't know why he's being chased, and it seems everything is against you. He clearly has no value, being taken out on sight. His deaths come suddenly, in moments that seem to be designed to kill. The camera lingers on his corpse a little too long, he struggles a little too much before succumbing, and such moments will provoke a pang of pity for the tiny boy in the red sweater.

Restarts are fast enough, though, and each time you die, you learn something, even if it's that you need to swing further, swim deeper, or pull a lever at a different moment. *Inside* is, at heart, a puzzle game—City 17 without the gravity gun—as you drag items to hide behind, throw switches, and alter water levels. You start off being chased, and you'll be pursued again before the adventure reaches its end, but much of the time you're doing this just to proceed. There's a lot of running to the right in *Inside,* entire rooms and rooftops exist for no reason but to be moved through, yet in the background there are often details that help you build up the story. This method of pulling the story out of the environment keeps you moving on as much as the pursuit and inevitable death upon capture.

Being picky, some of the puzzles lean too heavily on trial and error, but the solutions are never so obscure they don't seem obvious after you've solved them. Many rely on timing, light platforming skills, and a touch of lateral thinking. They're not so hard as to artificially lengthen the game, though—you'll complete it within five hours.

Inside is going to be overlooked thanks to its simple looks, two-button control scheme, and obvious console roots. This would be a mistake. Being with the boy on his journey, and seeing how it unfolds, is an experience that will drag you in, and provide you with the motivation to see it through. *Inside* is well worth your time. **–IAN EVENDEN**

VERDICT 9

Inside

+ ESCAPE Lovely art style; simple controls; great storytelling.

− CAPTURE Some obscure puzzles; death comes easily.

RECOMMENDED SPECS Intel i7 920 @ 2.7GHz or AMD Phenom II 945 @ 3.0GHz, 8GB RAM, Nvidia GTX 660 or Radeon R9-270.

$20, www.playdead.com, ESRB: M

LAB NOTES

ALEX CAMPBELL, ASSOCIATE EDITOR

Bigger Isn't Always Better

Pascal is making Mini-ITX more attractive

FOR THE PAST FEW MONTHS, I've been finding more and more reasons to build small form factor PCs. To be clear, I'm talking Mini-ITX and microATX motherboards. There are a lot of justifications for this personal trend of mine, the foremost being form factor.

I used to be in the camp that saw big towers of power as the be-all-end-all of PCs. The bigger the tower, the cooler it seemed. Nowadays, I find myself more impressed with Mini-ITX builds. Mini-ITX cases tend to be much more varied in appearance and layout than their ATX mid-tower brethren.

The recent GPU releases are also reason to go small. The GTX 1080 and 1070 both surpass the performance of the Titan X for a fraction of the price. With performance like that, you can reap more power out of a single-GPU system, and reduce the arguments favoring an SLI build. After all, Nvidia says its GTX 1000 series delivers less performance in 3-way SLI than 2-way SLI. Unless you're planning on adding a soundcard or PCIe SSD, there's little reason to get anything bigger than microATX.

Of course, there's always one big element that nixes this point of view: liquid cooling. Custom liquid-cooling loops, for the time being, still require large amounts of space for reservoirs, radiators, pumps, and tubing. However, there's still room for liquid cooling in Mini-ITX cases, too. Our own Zak Storey built an amazingly clean-looking liquid-cooled Mini-ITX rig in an NZXT Manta just a few issues ago. As big as the Manta is, it's still smaller than your typical mid-tower.

There's one more thing that might give some pause: The ASRock X99E-ITX/ac is currently the only Mini-ITX X99 motherboard available. While there is a good crop of microATX X99 and Mini-ITX Z170 boards to choose from, it would be nice to have more Mini-ITX X99 options.

If you're thinking about building a new rig, consider a Mini-ITX build. It'll be lighter, more compact, and you might just get something that's a little more unique than you're used to.

The ASRock X99E-ITX/ac is one of a kind.

TUAN NGUYEN

Editor-in-Chief

Cooling a graphics card is no joke. I found out recently how important different coolers are to maintaining low temperatures, especially with more than one display. Connecting two displays drove up the core frequency and voltage, resulting in my GTX 980 Ti idling at 68 C. In case there's any doubt, that's hot. I was using a reference card with a blower-type fan. In search of a solution, I swapped out the reference GTX 980 Ti for EVGA's GTX 980 Ti Hybrid. The Hybrid has a built-in all-in-one liquid cooler. That means it has a full custom metal heat plate covering the entire card, as well as a large 120mm radiator. The result? My idle temps dropped to 37 C. Pick your cards carefully!

JARRED WALTON

Senior Editor

Doom now has a public Vulkan patch, which potentially means better performance for everyone. Being a vendor-agnostic game, we're really glad to see some improvements on both AMD and Nvidia GPUs, but Vulkan can't work miracles, of course. It mostly helps when the CPU is the bottleneck, either because you have a fast GPU, or because you have a really slow CPU. There's no major drop in performance with Vulkan compared to OpenGL, and non-Windows users can also benefit from the low-level API. Unfortunately, it's still missing multi-GPU support, however, which is a continuing theme with games that use low-level APIs.

Editors' Picks:
Digital Discoveries

Zak Storey, Staff Writer, and Alan Dexter, Executive Editor, reveal their tech loves

99.9% PURE ISOPROPYL ALCOHOL

A day rarely goes by when we're not swapping out a CPU or two from a rig or test bed. It's almost continuous. Benchmark system A, take the cooler off, swap to system B, clean up, apply fresh thermal paste, lock the cooler down once more, benchmark, swap to system A again. Over and over. Sometimes it gets a little stressful, and you need a quick tipple to help you get through it. So, what better than 99.9% alcohol?

I joke, of course, but it is one of the most useful products we have in the office. In short, it's a fantastic cleaning agent: spray it on a bit of cloth, then rub your processor and CPU block clean of any nasty gunk that's left after swapping over a cooler or a heatsink. The alternative is some good old-fashioned elbow grease, but that takes a lot of effort, and has a nasty habit of leaving a residue on the processor, creating imperfections between the CPU lid and the heatsink. It's also great for cleaning keyboards, mice, brushed aluminum, you name it.

Disclaimer: *Maximum PC* does not condone or encourage alcohol abuse with 99.9% isopropanol, to any degree. Please note, 99.9% alcohol is highly flammable, an irritant, and toxic to humans.

$7, www.amazon.com

STEELSERIES FREE MOBILE WIRELESS CONTROLLER

When it comes to rest and relaxation, the PC is my platform of choice. But the problem with gaming on a desktop PC is that it isn't that portable. Dragging my machine into the sitting room to have a game while the family watches TV isn't practical. Which is why the other device I turn to is my slightly dated, but still impressive, Nexus 10.

Obviously, the games aren't at the same level as on the PC, but a tablet can be far more convenient. There are plenty of games that run well on tablets, and while many make a virtue of the touch input, some struggle. One game that has been a constant since buying the Nexus 10 is EA's *Real Racing 3*. Unfortunately, controlling it isn't always easy. That's where the Steelseries controller comes in. This diminutive device fits nicely in the hand, and is precise where touch controls often aren't. It's Bluetooth, too, so it'll work with your cell and laptop.

The model I've been using for the last few years has been replaced with more affordable offerings (at launch, it cost $115). The Stratus XL for Windows + Android is bigger, with more buttons, and costs almost half of what my original did, and is probably what I'll be treating myself to next.

$115, www.steelseries.com

GEEK TESTED & APPROVED

Magic: The Gathering Eldritch Moon

ELDRITCH MOON is the latest expansion for *Magic: The Gathering,* a card game that has survived where many have fallen. The latest assaults on the venerable franchise come in digital form, with the likes of *SolForge, Infinity Wars, Hex,* and *Hearthstone.* Of these, *Hearthstone* has made most headway, being particularly successful on Twitch, thanks to its vibrant style and simplicity.

Hearthstone may be incredibly polished (it's a Blizzard game, after all), and make the most of its digital environment, but it feels lacking when it comes to the actual game—you can't do anything on your opponent's turn, and the templated cards lack versatility, despite several set releases and the necessary splitting into Wild and Standard formats. *Hearthstone* does plenty right, but the game just isn't deep enough. At least for me. In fact, *Hearthstone* got me back into *Magic* again after a considerable break.

At the time of writing, it's hard to say just how good *Eldritch Moon* is, or what impact it will have, but given Wizards' recent form, I expect it to be another hit. The new game mechanics are interesting, if not revolutionary—Escalate is a variation on the Kicker, while Emerge can be used to reduce costs by sacrificing creatures, and Meld combines two cards to make one big one. Wizards of the Coast knows what it's doing, and the latest expansion feels polished, has a great theme, and looks set to be around for a while yet. **–AD**

$4 per booster, http://magic.wizards.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> A Future-Proofed Rig
> Reference Builds
> Administrator Access

Built to Last

I've subscribed to the magazine for a few years, and I've built two computers. I am not a gamer; I read to keep up with the latest technology. Could you make a list for me of a rig that will last a good number of years? I mostly use the computer for Internet purposes (streaming especially). I love blue lighted fans with the big window on the side. Nothing flashy, either. **–Peter H**

SENIOR EDITOR JARRED WALTON RESPONDS: The "Blueprint" near the back of each issue is a good place to start for parts lists, but it sounds as though you're wondering about the gaming—or, more specifically, non-gaming—aspects of building a PC. Truth is, outside of professional applications and games, there aren't a lot of things that are really pushing the limits of current technology. One of my old PCs is an overclocked i7-920 (3.33-3.50GHz) from early 2009, which has now been relegated to media streaming duties, as well as handling the needs of my wife and children. 12GB RAM and an upgrade to a 480GB SSD keep it humming along happily, and we use it daily for streaming services including Vudu, Amazon Prime Video, Netflix, Hulu, YouTube, and more. It does have a relatively modern graphics card (GTX 770), but 95 percent of our use doesn't even need that.

Other than the choice of a case, which is aesthetic as much as anything, building a PC that will last for years has never been easier. Depending on your budget, you could go for an i5-6500 or an i7-6700K, 16GB of memory, and a 500GB class SSD. Add in an appropriate motherboard and case (ATX, mATX, or mITX, depending on your preference), a decent 80 Plus Bronze or better PSU, and you should be golden. You probably don't even need a dedicated graphics card, as Intel's HD 530 Graphics are normally fine for casual Internet use.

The one caveat is that some streaming services are starting to shift to higher quality encoding, using H.265. For that, you might benefit from an updated graphics card, but as you're not gaming, I'd look for something inexpensive, such as AMD's Radeon RX 460. You can always add the graphics card later, so start with the other components, and try out some of your favorite apps and sites first, to see how they respond. Then, if you find things aren't working as well as you expected, drop in a graphics card—but you probably won't need to do that.

What's the Zero-Point?

The latest issue was great; the article on the command line brought back memories from my DOS days....

Regarding placement of fans on rads, I think it does make a difference if you have fans installed to push rather than pull. If you measure, you'd see that the magnitude of the discharge pressure on a fan is higher than the suction pressure, since it's an open system. So with the higher delta-P across the radiator, you'd get more flow. In practical terms, though, it may not be significant.

Also, from "Build It," you referenced a Core i7-6700K and an R9 Fury at 1080P as your reference build. I thought the reference build was a Core i7-5820K and three GeForce GTX 980s in SLI, with graphics at 4K or 1440P. Color me confused. **–Rona Matlow**

STAFF WRITER ZAK STOREY RESPONDS: We're looking at writing an in-depth feature on fan orientation and whether it does make a difference. It's certainly worth investigating.

As far as the reference machine goes, we recently decided to update it. As the online team has moved across to work with *PC Gamer*, we decided to re-evaluate some of our aging benchmarks, and also rework our zero-points, including laptops, gaming notebooks, and so on. It comes down to the idea that a zero-point should either be something everyone can attain, or that the majority of the community has access to. And being realistic, an Intel Core i7-5820K alongside triple GTX 980s just doesn't fit that bill.

We have to take into account our audience demographic, so we decided to swap it out with the water-cooled machine we built a couple of issues back as a general all-rounder. As we tend not to focus too much on temperature-based benchmarks, the water cooling would have minimal impact on overall test scores, especially as the CPU is only overclocked up

↘ submit your questions to: comments@maximumpc.com to 4.6GHz for those figures, so nothing outrageous.

We actually test at multiple resolutions during our benchmarking procedure, but we only report the 1080p figures in the tables. Again, this is to try to make it easier for our audience to compare their own machines against the systems we build. If you take a look at the latest Steam Hardware Survey, those using screen resolutions above 1920x1080 only account for 5 percent of those questioned.

Elevated Privileges

Under the heading "More Like the Stop Menu," your tip is: "What you need to do is give yourself administrator access on your account. If it's your PC, you should normally be logged in as administrator if you ever want to get anything done."

I'm afraid I must take exception to this tip. When you run as administrator, you give yourself extra privilege to screw your system, inadvertently or otherwise. Drive-by downloads, bugged images, whatever malware uses is made simpler for the malware author if they have complete privilege to do anything on your system. By logging on as a non-administrator account, you make their efforts at least a little bit harder.

You should NEVER use an administrator account without a specific need for administrator privilege, and then only to accomplish the specific task that requires administrator privilege. Once that task is accomplished, switch back to a non-administrator logon. **–James H. Wise**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: In many ways, you're spot on with this way of working—for the great unwashed, normal Windows user, we agree that logging on as a non-administrator account makes the most sense. However, when it comes the *Maximum PC* readership, that would only lead to annoyance—we're much more likely to mess with serious settings here, and the limitations of non-administrator accounts would push most of our readers over the edge. Having said that, this is something we're going to be looking at in a future issue. Also, when it comes to protecting yourself online, we've handily got a feature on that very subject this issue—turn to page 38 and read on.

A Man Needs a Name

In the August 2016 issue of *Maximum PC*, on page 14, there is a small article titled "Windows 7.0 Update Update." In this small article, it mentions going to the Microsoft Update Catalog site to download a file that has all the fixes for Windows 7. Unfortunately, the printed article never mentions the name of the file that one needs to search for to get it. That is no small error on the part of someone—the whole point of the article would hinge on that critical detail.

Could you please let me know what that file name is that should be searched for, as well as perhaps printing an update in an upcoming issue, and perhaps even mentioning it on the *Maximum PC* website and Facebook page (I checked both of those places before emailing you, and initially saw nothing in regard to it)? **–Wilson Moffitt**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: The update is called the Windows 7 SP1 convenience rollup, which we did mention in the news article, but just to clarify, you can find out more by pointing your browser at https://support.microsoft.com/en-us/kb/3125574. From there, you'll find links to the actual file in question over at the Microsoft Update Catalog website (although it's worth noting that you'll want to use Internet Explorer to actually grab the file).

[NOW ONLINE]

WHAT YOU NEED TO KNOW ABOUT GPU COOLERS

Buying a new graphics card can be intimidating to someone who's new to PC building, or even someone who hasn't updated their card in years. It's totally understandable. There's a slew of factors to consider, after all: GPU clock, memory capacity, size, and price, just to name a few. It's enough to make a newcomer's head spin at 7,200rpm.

One of the things that is considered less often is the implications of the graphics card's cooling design. Not all designs are created the same, and your choice has a big impact on how you approach the rest of your build. Read the full story at: http://bit.ly/2a5mivQ

Giving You an Update

I have been putting together my own systems since I was 11. Recently, I started putting together a new one, just a day before the August issue came to my mailbox. My current build is an Intel i7-6700K, Gigabyte G1 Gaming 7, 16GB DDR4 3,600MHz, 512GB 950 PRO, 1TB 850 EVO, 4TB WD Black, H100i water cooler, and—oh yeah—a GeForce GTX 1080.

Most of the main components are picked on the basis of recommendations from the many issues I have read of your magazine. Aside from some issues trying to install Windows 7 on an NVMe drive, for which the install doesn't have driver support, everything went relatively smooth. Probably the biggest help was knowing that the Windows update (unofficial) SP2 was out there, saving me potential hours/days of updating. After spending about 15 minutes sifting through the website, I decided to just go and start updating without any download off the site. As fate would have it, "Rollup update for ActiveX Killbits" was there. Just goes to show the fast-paced nature of technology. **–Matthew Sumrada**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: That's good to hear. Dare we hope that this is a sign that Microsoft is finally warming to the idea that prioritizing updates is the way forward? If anyone else is having problems finding the update, check out the link from the previous question.

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THE BUILDS

BUDGET GAMER

INGREDIENTS

PART			PRICE
Case	Thermaltake Core V1		$48
PSU	EVGA G2 550W	**NEW**	$75
Mobo	ASRock H170M-ITX/ac		$100
CPU	Intel Core i5-6500		$200
GPU	XFX Radeon RX 480 4G	**NEW**	$200
RAM	8GB (2x 4GB) G.Skill Aegis DDR4-2133		$34
SSD	240GB SanDisk Ultra II 2.5-inch SATA		$71
HDD	1TB Seagate Barracuda 7,200rpm 3.5-inch SATA		$50
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit		$16

Approximate Price: $794

SAY GOODBYE to the R9 series. In this build, we're introducing AMD's RX 480, with a reference model from XFX. One important thing to note is that this is the 4GB model. To keep our total below $800, we had to go with that instead of the 8GB model. Don't get us wrong: The 4GB model will perform just fine, with a significant improvement over the R9 380. However, if you'd like to make room for some of those bigger textures, the 8GB rendition might serve you better. The RX 480 is still primarily a 1080p card, though it accomplishes its task with relish. We also chose to change up the power supply to an EVGA model. The reason for this was price, as both EVGA and Corsair make very good power supplies. Depending on the prices you can track down, you'll be fine with either PSU maker. Looking down the rest of the list, we found a few savings here and there, but prices stayed generally the same. CPU prices, in particular, tend to stay pretty static.

MIDRANGE

INGREDIENTS

PART			PRICE
Case	NZXT Manta	**NEW**	$130
PSU	EVGA SuperNOVA G2 650W 80 Plus Gold		$90
Mobo	Gigabyte GA-Z170N-Gaming 5	**NEW**	$155
CPU	Intel Core i5-6600K		$230
Cooler	Corsair H100i v2	**NEW**	$105
GPU	Asus GeForce GTX 1070 Strix 8G	**NEW**	$430
RAM	16GB (2x 8GB) G.Skill Ripjaws V Series DDR4-2400		$60
SSD	250GB Samsung 850 EVO M.2		$100
HDD	Western Digital Black Series 1TB 7,200rpm		$70
OS	Windows 10 (*Download*)		$110

Approximate Price: $1,480

SAYONARA, TOWER! It's the return of the Mini-ITX midrange. This time, the build is making its home in the surprisingly spacious NZXT Manta, which has room for two mounting positions for the radiator: up front, or up top. For this case, we recommend mounting the radiator up top, as the Manta comes with two intake fans at the front. It's one less thing to remove and reattach elsewhere. To fit the system in the case, we had to (obviously) find a Mini-ITX mobo. Gigabyte's G1 GA-Z170N-Gaming 5 is a solid board that doesn't break the bank. If there's one issue you might have, it's the location of the USB 3.0 front panel connector, which eliminates the possibility of hiding the USB 3.0 cable. Of course, if you're not a stickler for the ultra-clean look, it's not a big deal. We also went with Asus's GTX 1070 Strix for pixel-pushing. Prices for Pascal cards are still a bit wacky due to inventory issues. Luckily, Asus's model stuck at the $430 mark we hit last month.

TURBO

WE CHANGED UP A BUNCH OF THINGS for the Turbo this month, but what should draw your attention is what we didn't change. Despite the launch of Intel's Broadwell-E line of CPUs, we're sticking with Haswell-E for now. Why? Price. At $384, the Core i7-5820K is the lowest tier of the Haswell-E line. In comparison, the lowest-tier Broadwell-E chip, the i7-6800K, goes for about $430, depending on where you look. That's nearly a $50 difference in price, for a CPU that offers up little more than improved clock speeds. We can see the 6800K becoming a good option, but it has to close the price gap with the 5820K first. As you should have noticed from the image, we did change up our case. The Phanteks Enthoo Evolv ATX is an awesome all-aluminum case that looks handsome, and offers great features. There's plenty of room for liquid and air cooling, and cable management is a breeze. The rest of our build is a slight shuffling to make budgetary room for things. We dropped down to a 750W PSU, for instance. With the reduced power draw of the GTX 1080s, we still had plenty of room for CPU overclocking. As for RAM, we were able to save a little money by dropping down to 2,666MHz. We also got rid of the second hard drive. There's no need to worry, though—should this build ever need another hard drive, the Enthoo Evolv ATX has plenty of options to make sure the drive is installed elegantly.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Evolv ATX	**NEW**	$170
PSU	EVGA SuperNOVA G2 750W	**NEW**	$108
Mobo	MSI X99A SLI Plus		$230
CPU	Intel Core i7-5820K		$384
Cooler	Corsair H100i v2		$105
GPU	2x PNY Nvidia GeForce GTX 1080 Founder's Edition		$1,400
RAM	16GB (4x 4GB) G.Skill Ripjaws 4 Series DDR4-2666	**NEW**	$82
SSD	512GB Samsung 950 Pro M.2 (NVMe)		$315
HDD	1TB WD Black 7,200rpm 3.5-inch SATA	**NEW**	$70
OS	Windows 10 (*Download*)		$110

Approximate Price: $2,974

UPGRADE OF THE MONTH

AMD RX 480 8GB

Hot on the heels of the GTX 1070 and 1080 launches was the arrival of AMD's Polaris-based GPU, the RX480. The RX 480 is aimed at the budget and mid-tier crowd, and makes solid improvements over the R9 380. While it's still far behind the GTX 1070 in terms of raw performance, the RX 480 beats nearly every other card in its price/performance ratio.

$240, www.amd.com

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